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PRACTICAL SURVEYOR;

BEING A

Treatise on Surveying;

DESIGNED FOR

THE USE OF SCHOOLS.

48923

BY THE

REV. JOHN FURNASS.

——: HINC LAUDEM FORTES SPERATE COLONI. *Virg.*

NEWCASTLE:

PRINTED FOR THE AUTHOR, BY S. HODGSON; AND SOLD BY E. CHARNLEY AND SON, AND THE OTHER BOOKSELLERS IN NEWCASTLE;
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AND MESSRS. CRADOCK AND JOY,
LONDON.

1809.

TO THE

HONOURABLE AND RIGHT REVEREND

FATHER IN GOD,

SHUTE,

BY DIVINE PROVIDENCE,

LORD BISHOP OF DURHAM.

H 8973.

My Lord,

THE many obligations I am under to your Lordship, were the prevailing motives of my mind in presuming to solicit your Lordship's name to my humble adventure in Mathematical Researches. As a small acknowledgment, therefore, of such obligations, rather than from an expectation that I can offer any thing worthy acceptance, the following sheets are presented to your Lordship;—well knowing that high opinion the world has of your Lordship's abilities and acuteness of understanding, in the most exquisite and refined parts of Education.—The active zeal your Lordship has

shewn, in promoting the establishment of schools, and affording the means of rightly instructing youth, will be lasting monuments of the unbounded goodness and liberality of your Lordship's disposition. Suffer me, then, my Lord, to shelter this specimen of my labours, in the humble paths of science, under that protection from which so much good has resulted.—Actuated by the principles of gratitude and acknowledgment, believe me to be, with the most profound respect,

Your Lordship's much obliged,

Devoted humble Servant,

JOHN FURNASS.

PREFACE.

THE following sheets were drawn up for the use of my own school, without the least intention of being made public: but finding, by experience, the advantages of the method there laid down, and its tendency to elucidate the important subject of Land Surveying, I determined therefore, to communicate to many what had been only useful to few.

Amongst the several branches of mathematical learning, *Surveying* seemed to me to claim a distinguished rank—if not pre-eminence: Its great utility in ascertaining the areas of commons, and pointing out the limits of estates is so well known, that it would be preposterous (in me) to offer an explanation. Suffice it to say, that without a knowledge of Geometry,

aided by the practice of Surveying, this habitable world (if I may so speak) would have been little better than an indigested chaotick surface; but since the dawn of science upon the human mind, and by the indefatigable industry of the husbandman, it is now spread over with a pleasing variety, and intersected with hedges, clothed in beauties, which break in upon the sight with new delight and ever increasing admiration.

Any apology from me respecting the work may not be expected.—An attempt to simplify any part of science claims indulgence; and should it even fail in some particulars, it is still praiseworthy.

There is little new in the following pages,—unless the selection and arrangement of the various articles therein contained, may be ranked amongst works of originality. And let it be understood, that I have taken an unreserved liberty with any matter that seemed to solicit

my attention.—In several instances it will be seen, that I have even dared to deviate from the common mode of teaching, and ground my reasons for so doing upon the experience of a number of years.

To the few Geometrical Problems with which the book begins, I have attempted to give succinct demonstrations, founded on the very nature of these particular Problems, without any reference to other writers.—This may (by some preceptors) be thought novel, but in taking a nearer view of the subject, it will evidently appear that those short reasonings may tend to expand the ideas of the young scholar, and excite him to higher researches in the more sublime parts of science.

In the practice of the chain I have been more than particular;—the master will find, by an attentive perusal of the subject, various forms and modes so well adapted to his purpose, and so proper to be laid before his pupils, that by

transcribing the field books and planning from the same, they will soon be qualified to enter upon actual surveys. The two last examples of Chain-surveying unfold the methods practised by surveyors of the first eminence, in the application of that useful instrument; and the preceding will tend to make the student particular, and prepare the mind for a more extensive range in the art of Geodæsia.

I have likewise added whatever I thought might be of use to the master and scholar, and consequeutly have furnished diverse examples, wherein the mode of applying the Plain-Table and Theodolite, in actual surveys, is developed. —The method of reducing hypothenusal lines to horizontal, in measuring hilly ground, is explained.—The laying out and dividing of lands are particularly noticed.—And Levelling comes last, wherein the theory and practice of that art are fully investigated.

In short, utility being the principle motive of

the publication, every thing superfluous and puzzling has been carefully avoided;—keeping constantly in view the title of the work and its design.—And should I fail in fulfilling the expectations of (I had almost said) an unexampled patronage; yet, I trust, I shall be acquitted of all presumption, and the whole will be attributed to its true cause,—which is the ardent desire of "Teaching the young idea how to shoot."

J. F.

Ponteland, May 4, 1808.

EXPLANATION

Of the Marks and Characters made use of in the following Work.

\+ is the sign of addition.
— ——— subtraction.
× ——— multiplication.
÷ ——— division.
= ——— equality.
: :: : ——— proportion.

⊙ L. signifies station line.
O. R. ——— offsets taken on the right hand.
O. L. ——— offsets taken on the left.
⌜ ——— turn to the right hand.
⌝ ——— turn to the left.
< ——— angle.

^ Is placed over an offset, to shew that it is not taken at right angles with the chain line, but in the line with some straight fence.

No. 1, 2, 3, &c. A, B, C, &c. and *a*, *b*, *c*, &c. are numbers and marks, set upon a piece of paper or a chip of wood, and left in the field in a hole or under a stone at the time they were entered in the field book; which serve to point out, on any return to them, the true line, &c. upon which they stand.

Where the words *leave off* are written in the field book, it is to signify that the taking of offsets is from thence discontinued; and of course something is wanting between that and the next offset.

THE

PRACTICAL SURVEYOR.

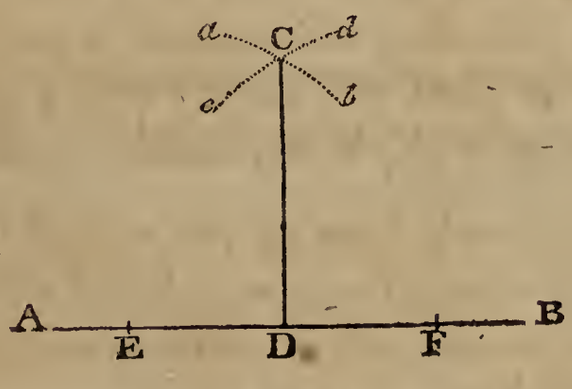
GEOMETRY.

GEOMETRY is a science, which explains the affections of lines and angles, plains and solids.

The Geometry intended in this place is only what is necessary to facilitate the progress of the young Surveyor.

PROBLEM I.

Upon a given right-line AB to erect a perpendicular CD, in the point D.



I. Method.

Take, on either side of the point D, the distance DE=DF; set one foot of the compasses in E and F, and, with any opening, strike the arcs *ab*, *cd*, cutting each other in C; then draw CD, and it will be the perpendicular required.

II. Demonstration.

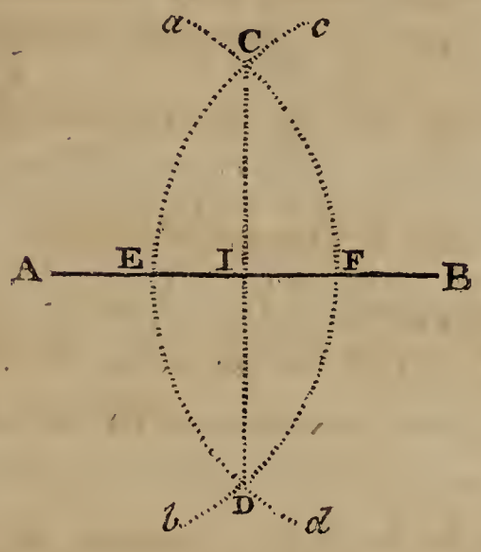
Conceive the points CE, CF to be joined; and the triangles CDE, CDF, having two sides of the one respectively equal to two sides of the other by construction, and the line CD common, are equal; consequently the line CD is in the middle (making the angles on each side right*), and therefore perpendicular to the given right-line AB. Q. E. D.

Remark.—If it were required to erect a perpendicular at the end of a given right-line.—Produce the given line, and proceed as above: or, when a perpendicular is to be let fall from a given point,—the above method and proof will still obtain.

* A right-angle is 90 degrees, or a quadrant; the whole circumference of every circle being supposed to be divided into 360 equal parts, called degrees.

PROBLEM II.

To bisect a given right-line AB.



I. Method.

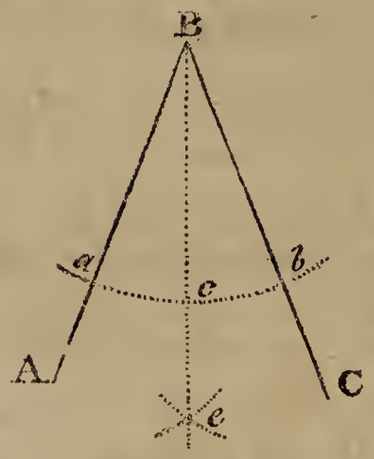
With any opening of the compasses, upon the extremities A and B, describe the two arcs *ab*, *cd*, cutting each other in C and D; through the points of intersection draw the right-line CD, and it will bisect the given line AB in I.

II. Demonstration.

By construction AF=BE, arc CED=arc CFD, and the right-line CD, common to both segments, divides the included distance EF in the middle; whence IA=IB, and the right-line AB, is bisected in I. Q. E. D.

PROBLEM III.

To bisect a right-lined angle ABC.



I. Method.

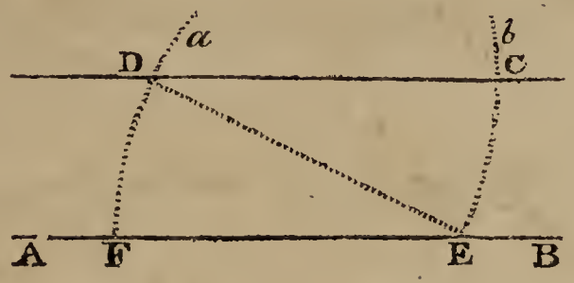
From the point B, with any radius, describe the arc *ab*; and on the points *ab*, with the same, or any other radius, describe arcs cutting each other in *e*; draw the line B*ce*, and it will bisect the angle ABC.

II. Demonstration.

Conceive the points *a* and *b*, *a* and *e*, and *b* and *e*, to be joined; and the triangles on each side of the bisecting line are equal, by construction; therefore *ce* is in the middle, and perpendicular to the imaginary chord *ab*, which being continued, will pass through the centre B, and bisect the angle ABC; because B*a*=B*b*, and *ca* =*eb*. Q. E. D.

PROBLEM IV.

Through a given point D, to draw a right-line DC, parallel to a given right-line AB.



I. Method.

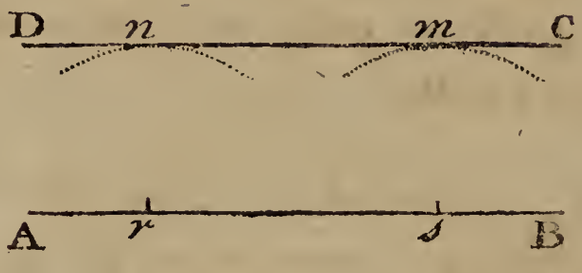
From the point D, draw, at pleasure, the oblique line DE; on the points D and E respectively, and with the same radius, describe the arcs *b*E and F*a*; make the arc EC=FD; then through the points D and C, draw the line DC, and it will be parallel to AB.

II. Demonstration.

By construction DC = DE = EF, and EC = DF; whence ∠FED= ∠EDC, and therefore DC is parallel to AB. Q. E. D.

PROBLEM V.

To draw a line DC, parallel to a given line AB, at a given distance.



I. Method.

From any two points *r*, *s*, in the right-line AB, with an opening of the compasses equal to the given distance, describe the arcs *n*, *m*; then draw the right-line DC, to touch those arcs without cutting them, and it will be parallel to AB.

II. Demonstration.

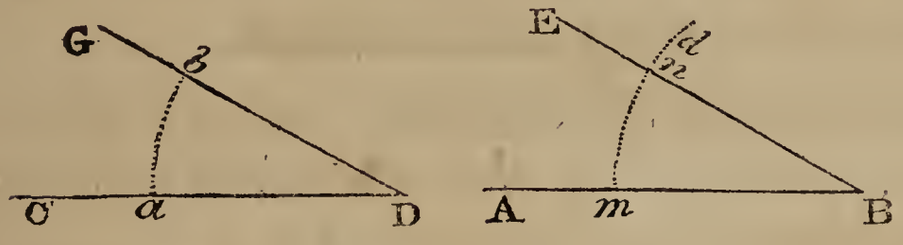
Conceive *rn* and *sm* to be joined, and both these imaginary lines will be perpendicular to the given right-line AB, and also equal to the given distance by construction; therefore the right-line DC, touching the arcs at the highest points of the curves (without cutting them), is a tangent at *m*, *n*; and consequently the line DC is parallel to the given line AB. Q. E. D.

Note.—This and the former Problem, as well as several other operations in Practical Geometry, may

be more easily effected by means of the parallel ruler.*

PROBLEM VI.

At the end B of a given right-line AB, to make a right-lined angle equal to a given right-lined angle CGD.



I. Method.

Upon the angular point D, with any radius, describe the arc *ab*, and with the same radius, from the extremity B, describe the arc *md*, on which take *mn*=*ab*; and through the points B*n*, draw the line BE, and the thing is done.

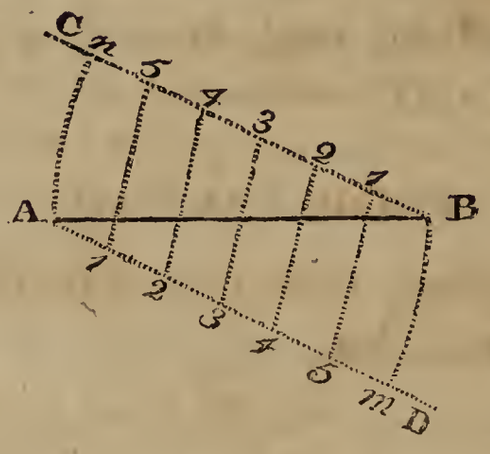
II. Demonstration.

By construction, B*m*=D*a*, B*n*=D*b*, and arc *mn*=arc *ab*; whence ∠ABE= ∠CDG. Q. E. D.

* Parallel ruler is a mathematical instrument, consisting of two equal rulers, either of wood or metal, connected together by two slender cross bars or blades, moveable about four points or joints. This ruler may be had of all sizes,—but it is usually put into a portable case, with a drawing-pen, scale, compasses, and other useful instruments.

PROBLEM VII.

To divide a right-line AB into any number of equal parts; suppose six.



I. Method.

From one end of the line A, draw A*m*, making any angle with AB; and from B, the other end, draw B*n*, making an equal angle AB*n*; then on the line BC, beginning at B, set off as many equal parts, of any lengths, as AB is to be divided into, and also do the same on the line AD. Join the points 5 1, 4 2, 3 3, &c. as in the figure, and AB will be divided as was required.

II. Demonstration.

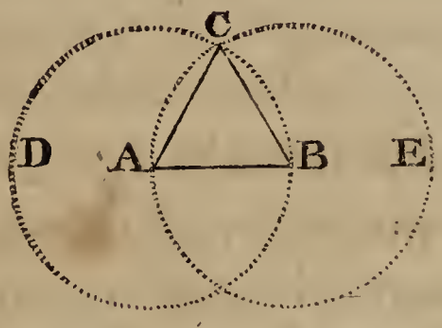
The triangles AB*m*, BA*n*, constituted on each side of the line AB, are equal and similar by construction; and

the distances A*m*, B*n*, being each divided into six equal parts, and joined by lines drawn through the given right-line AB, will, by the property of similar triangles, divide this line into six equal parts. Q. E. D.

Note.—B*n* may be drawn parallel to A*m*, by means of a parallel ruler.

PROBLEM VIII.

Upon a given right-line AB, to make an equilateral triangle.



I. METHOD.

From the centre A, with the radius AB, describe the circle BCD*,—and from the centre B, with the radius BA, describe the circle ACE; then from the point C, in which the circles cut one another, draw the straight lines

* A circle may be described from any centre, at any distance from that centre; and all the straight lines drawn from the centre to the circumference of the figure, are equal to one another.

CA, CB, to the points A, B, and ABC will be the equilateral triangle.

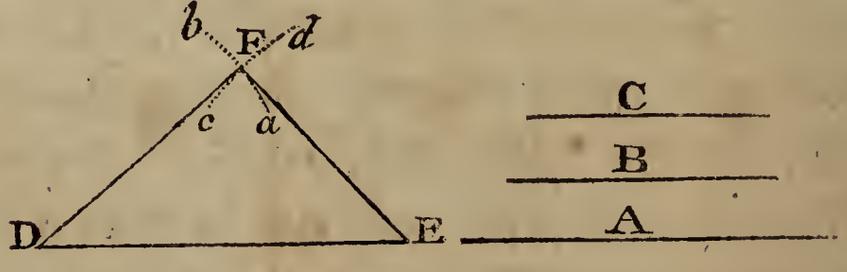
II. Demonstration.

Because the point A is the centre of the circle BCD, AC=AB; and because the point B is the centre of the circle ACE, BC=BA: But CA=AB, therefore CA=BC; wherefore CA=AB=BC: And the triangle AB is therefore equilateral, and is described upon the given straight line AB. Q. E. D.

Note.—An isosceles triangle may be formed in the same manner, by taking any distance for the radius; and the proof will follow from above.

PROBLEM IX.

To make a triangle, the three sides of which shall be respectively equal to the three given lines A, B, C.



I. Method.

Draw a line DE=A,—and on the point D, with a radius equal to B, describe the arc *ba*,—

and on the point E, with a radius equal to C, describe the arc *cd*, cutting the former in F; join DF, EF, and DFE will be the triangle required.

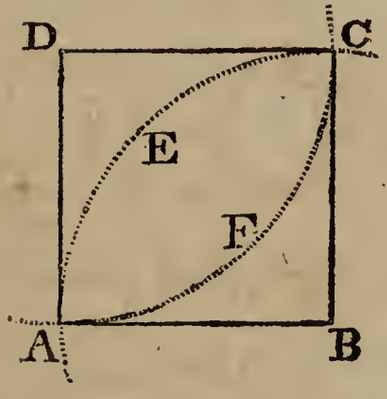
II. Demonstration.

Because the point D is the centre of the circle *b*F*a*, DF=B; and because the point E is the centre of the circle *c*F*d*, FE=C: But DE=A by construction; whence the triangle DFE is constituted of the three given lines A, B, C; and therefore is that which was required to be made. Q. E. D.

Note.—The three given lines must be each of such a length, that any two of them taken together shall be greater than the third.

PROBLEM X.

Upon a given line AB to describe a square.



I. Method.

From the point A, draw AD perpendicular,

and equal to AB; and on B and D, with the radius AB, describe the arcs AEC, AFC, cutting one another in C. Draw DC, CB, and it is done.

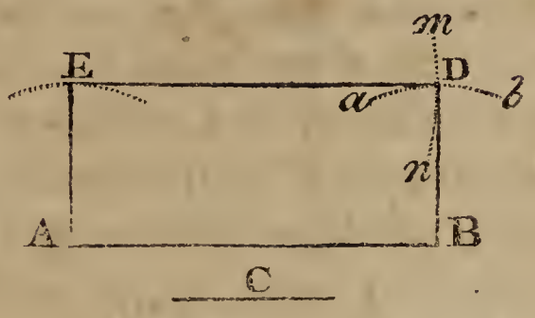
II. Demonstration.

Because the point B is the centre of the circle AEC, BC=AB; and because the point D is the centre of the circle AFC, DC=AB; but BC=AB, therefore BC=DC; but DA=AB by construction, and hence AD=DC=CB=AB. And because BC touches the circle at C without cutting it, BC is perpendicular to DC; but AD is perpendicular to AB by construction, therefore BC is parallel to AD.

Now, it has been proved that DC is perpendicular to BC, therefore DC is parallel to AB. Whence ABCD is a square (the angles of which are all right), and has been constructed upon the given right-line AB. Q. E. D.

PROBLEM XI.

To describe a parallelogram, the length and breadth of which shall be equal to two given right-lines AB and C.



I. Method.

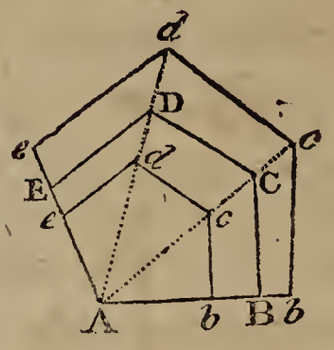
At the point A, in the given line AB, erect the perpendicular AE, which make equal to C; then from the points E, B, with the radii AB and C, describe the arcs *m*D*n*, *a*D*b*, cutting one another in D. Join ED and BD, and ABDE will be the triangle required.

II. Demonstration.

Because the point E is the centre of the circle *m*D*n*, ED=AB; and because the point B is the centre of the circle *a*D*b*, BD=C: But AE=C by construction, consequently BD=AE. And DE, touching the circles at the highest points of the curves without cutting them, is respectively perpendicular to BD, AE. But BD is parallel to AE, whence BD is perpendicular to AB; and therefore ABDE is the parallelogram required.

PROBLEM XII.

To make a figure similar to a given figure ABCDE.



I. Method.

Take A*b* equal to the side of the figure required, and from the angle A draw the diagonals AC, AD; then from the points *b*, *c*, *d*, draw *bc*, *cd*, *de*, parallel to BC, CD, DE, and A*bcde* will be similar to ABCDE.

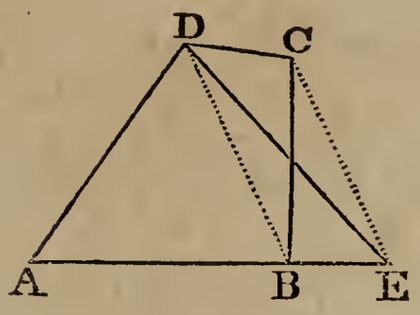
II. Demonstration.

By construction *bc*, *cd*, and *de* are respectively parallel to BC, CD, and DE; and therefore the triangles ABC and A*bc*, ACD and A*cd*, ADE and A*de*, are respectively similar. Whence AB : AC :: A*b* : A*c*, and AC : AD :: A*c* : A*d*, also AD : AE :: A*d* : A*e*; and therefore the figure A*bcde* is similar to the figure ABCDE. Q. E. D.

Note.—The same thing may be also done by making the angles *b*, *c*, *d*, *e*, respectively equal to the angles B, C, D, E; and the proof will follow from above.

PROBLEM XIII.

To make a triangle equal to a given trapezium ABCD.



I. Method.

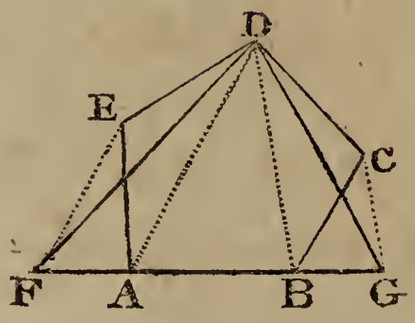
Draw the diagonal DB, and make CE parallel to it, meeting the side AB produced in E; then join the points D, E, and the triangle ADE will be equal to the trapezium ABCD.

II. Demonstration.

For, because the triangles BDC, BDE, are upon the same base BD, and between the same parallels BD, EC, BDC=BDE; and if ABD be added to both, then will the triangle ADE = the trapezium ABCD. Q. E. D.

PROBLEM XIV.

To make a triangle equal to a given right-lined figure ABCDEA.



I. METHOD.

Draw DA and DB, and also EF and CG parallel to them, meeting AB produced both ways in F and G; then draw DF and DG; so shall the triangle DFG = the right-line figure ABCDEA.

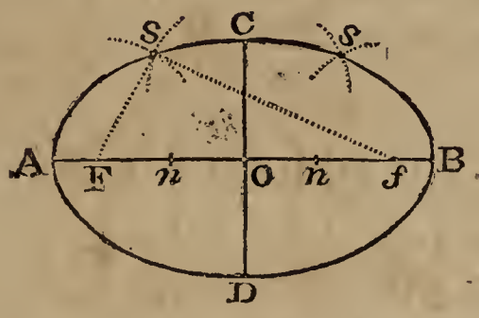
II. DEMONSTRATION.

Because the triangle DFA=DEA, which is upon the same base and between the same parallels,—and the triangle DGB=DCB being upon the same base and between the same parallels; therefore is the triangle DFG (=DFA+DAB+DBG = DEA+DAB+DCB) = the right-lined figure ABCDEA. Q. E. D.

Note.—Nearly in the same manner may any right-lined figure whatever be reduced to a triangle.

PROBLEM XV.

To describe an ellipsis, the transverse and conjugate diameters AB, CD, being given.



I. METHOD.

Draw the transverse and conjugate diameters AB, CD, bisecting each other perpendicularly in the centre O; then with radius AO, and centre C, describe an arc, cutting AB in F*f*; and these two points will be the foci of the ellipse. Now take any number of points *nn*, &c. in the transverse diameter AB, and with radii A*n*, *n*B, and centres F*f*, describe arcs intersecting each other in *ss*, &c.; then through the points *ss*, &c. draw the curve A*s*CBD, and it will be the circumference of the ellipse required.

II. METHOD.

Having found the foci F*f*, as before, take a

thread of the length of the transverse diameter, and fasten its ends with two pins in the points F*f*; then stretch the thread F*sf* to its greatest extent, and it will reach to the point *s* in the curve; and by moving a pencil round within the thread, keeping it always stretched, it will trace out the elliptic curve required.

III. Demonstration.

Imagine the two points FC to be joined; and it is well known that the two semi-axes, and the focal distance from the centre of the ellipse, are the sides of a right-angled triangle FOC; and the distance FC from the focus to the extremity of the conjugate axis=AO the semi-transverse: But by the property of the ellipse, the sum of two lines drawn from the two foci, to meet in any point in the curve, is equal to the transverse axis; and by construction F*s*+*fs*=AB, and the transverse and conjugate diameters are drawn as per figure. Therefore A*s*CBD is the ellipsis required. Q. E. D.

PROBLEM XVI.

To make plain diagonal scales.



I. Method.

Draw any line, as AB, of any convenient length. Divide it into eleven equal parts.* Complete these into rectangles of a convenient height, by drawing parallel and perpendicular lines. Divide the altitude into equal parts, if it be for a decimal scale for common numbers, or into twelve equal parts, if it be for feet and inches; and through these points of division draw as many parallel lines the whole length of the scale: Then divide the length of the first division, AC, into ten equal parts, both above and below; and connect these points of division by diagonal lines, and the scale is finished, after being numbered as you please.

* Only four parts are here drawn for want of room.

II. Use.

These diagonal scales serve to take off dimensions, or numbers of three figures. If the first large divisions be units, the second set of divisions, along AC, will be 10th parts; and the divisions in the altitude, along AD, will be 100th parts. If CB be tens, AC will be units, and AD will be 10th parts. If CB be hundreds, AC will be tens, and AD units. But if CB be thousands, AC will be hundreds, and AD will be tens. And so on, each set of divisions being tenth parts of the former.

EXAMPLE.

It is required to take off 243 from the scale.

Operation.

Fix one foot of the compasses at 2 of the greatest divisions, at the bottom of the scale, and extend the other to 4 of the second divisions, along the bottom; then, for the three, slide up both points of the compasses by a parallel motion, till they fall upon the third longitudinal line; and in that position extend the second point of the compasses to the fourth diagonal line, and you have the extent of 243 as required.

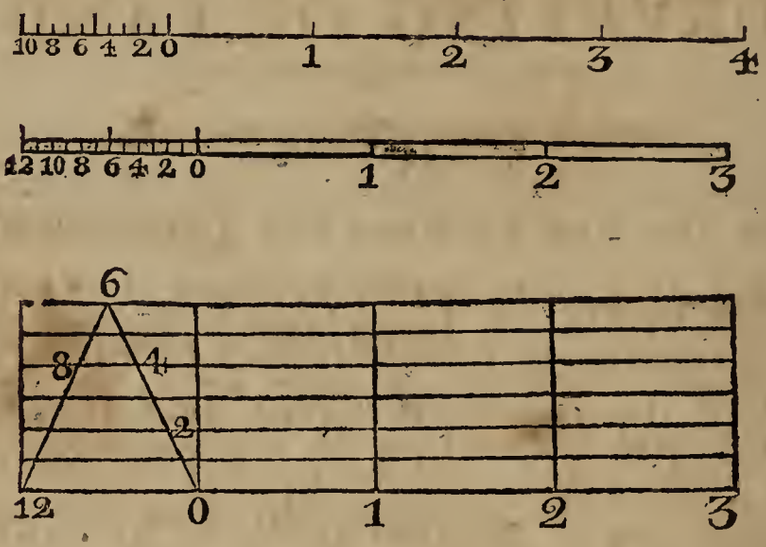
EXAMPLE.

It is required to measure the length of any line.

Operation.

Take the line between the compasses, and applying it to the scale, suppose it is 3 of the large divisions, or 3 hundreds,—and between 5 and 6 of the second divisions, or 5 tens or 50, and a little more. Slide up the points of the compasses by a parallel motion, keeping one foot always on the vertical division of 3 hundred, till the other point fall exactly on one of the diagonal lines, which suppose to be 8, which is 8 units. And hence the length of the line, which is proposed to be measured, is 358.

PLAIN SCALES FOR TWO FIGURES.



1. The above are three other forms of scales; the first of which is a decimal scale, for taking of common numbers, consisting of two figures: The other two are duodecimal scales, and serve for feet and inches, &c.

2. These, and other scales engraven on ivory, are fittest for practice. And the most convenient form of a plane scale of equal divisions is on the very edge of the ivory, made thin at the edge, for laying along any line, and then marking on the paper opposite, any division required; which is much readier than taking lengths off a scale with compasses.

SURVEYING OF LAND.

SURVEYING of Land teacheth the art of finding the content of any field, estate, or country, and shews how to represent the same upon paper. It also giveth rules for laying out lands into any particular form, or dividing them into any parcels, according to their quantity and quality.

TABLE I.

Of Square Measure.

Links	Yards				
20·657	1	Poles			
625	30·25	1	Chns.		
10000	484	16	1	Rood	
25000	1210	40	2·5	1	Acres
100000	4840	160	10	4	1

TABLE II.

Of Long Measure.

Inches	Links	Yards	Poles	Chns.	Furl.	Miles
7·92	1					
36	4·545	1				
198	25	5·5	1			
792	100	22	4	1		
7920	1000	220	40	10	1	
63360	8000	1760	320	80	8	1

The preceding Tables exemplified.

In 123·52 square chains, how many square links?

Here $123{\cdot}52 \times 10000 = 1235200$ square links; the answer.

In 10400000 square links, how many square chains and acres?

Answer—1040 square chains, 104 acres.

Find the number of square yards that are in 25 acres.

Answer—121000 square yards.

In 68340 square yards, how many acres?

Answer—14·12 acres.

Required the number of inches that are in 18 miles?

Answer—1140480 inches.

How many miles are equal to 1140480 inches?

Answer—18 miles.

To reduce customary measure to statute, and the contrary.

RULE.

As the square of the feet in a customary pole is to any number of statute acres, so is the square of the feet in a statute pole to the number of customary acres; and é contra.

EXAMPLES.

In 47 statute acres, how many customary acres of $6\frac{1}{2}$ yards to the pole?

As $380{\cdot}25\ (=\overline{19{\cdot}5}^2) : 47 :: 272{\cdot}25\ (=\overline{16{\cdot}5}^2) :$ 33A. 2R. 24P.; the answer.

In 30 customary acres, how many statute acres,—the customary pole being 7 yards?

Answer—48A. 2R. 15P.

SURVEYING BY THE CHAIN.

PROP. I.

*To measure a right-line with the chain.**

RULE.

Set up marks at each of the places betwixt which you are to measure, and call the place you measure from your first station, and the place you measure to your second station. Then, having an assistant, a chain and ten arrows, measure from your first station in a right line, to your second, and note the distance in your field book.

Should a hollow intervene which you can measure through, but which prevents your

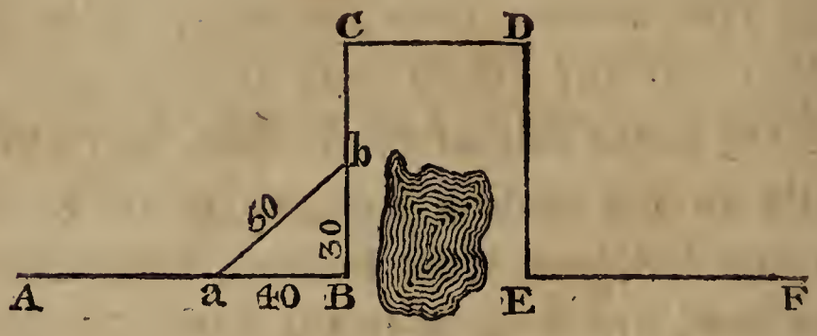
* The measuring chain is composed of 100 links of strong iron wire, each link 7·92 inches; therefore the whole chain is 22 yards, or 4 poles, in length. At every 10 links is fastened a piece of brass, cut into points so as to denote the number of tens. And the better to carry on the account of the number of chains, there are ten small arrows (often made of wood, though iron is preferable) used by the assistant, who has the foremost end of the chain, one of which he sticks into the ground at the end of each chain's length, which are collected by the hindermost chainman, or master measurer.

seeing your station when you are in it, let your assistant take the off-set staff, or any pole, and go to the other side of the hollow, and place it exactly in the station line, so as to be seen from the bottom of the hollow; then measure to the staff, and from it to the end.

Or, if you meet with rising ground which keeps your second station hid from you, take your assistant to the rising ground, and, at some distance from each other, move backwards or forwards till you see him in a right line with the second station, at the same time that he observes you in a right line with the first. There set up marks, and measure from your first station to these marks, and from them to the end of the line.

Should obstructions happen to be in the way, such as wood, water, &c. if you can, with convenience, pass one end, and your line of direction be not much altered by it, it may be done by raising perpendiculars in the manner following.

Measure from A to B, and then return 40 links to *a*, where make one end of your chain fast. This done, carry 50 links from *a* to *b*, and 30 links from B to *b*. Continue the line B*b* as far as necessary, suppose to C; measure CD, and raise the perpendicular DE, which



make equal to BC: At E raise another perpendicular, and measure to F. So shall AB+CD+EF be equal to the whole line AF. But if this method be found impracticable, some other way must be devised.

Note.—1. The method of raising perpendiculars with the chain is troublesome, but may occasionally be used when no other instrument is at hand. A cross does the work with much more expedition.

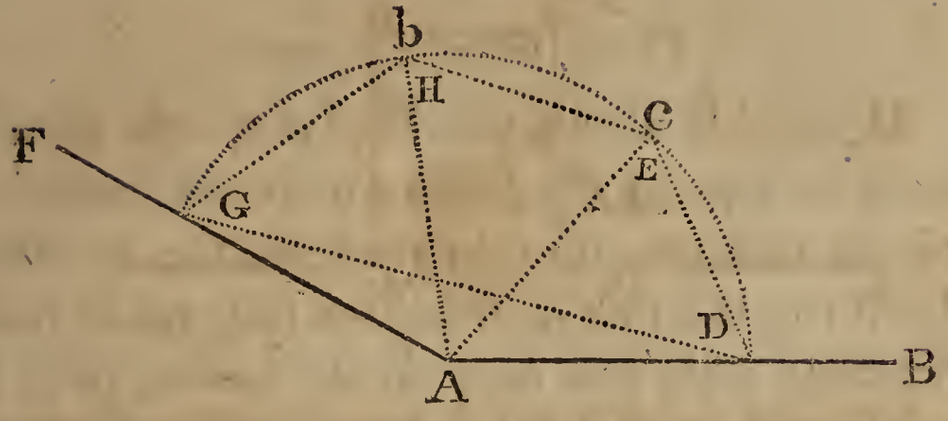
2. When you measure to a hedge, it is usual to allow five links from the stem of the quickset hedge, for the breadth of the ditch, when there is no agreement to the contrary.

PROP. II.

To measure any angle with the chain.

RULE.

Hold one end of the chain at the angular point A, and direct your assistant to place the



other end at D and G successively, where he must set up marks to be in a right line with the station-staves A, B, and F: Then measure the distance between the marks D and G, which will be the quantity of the angle. But if the angle be greater than a sextant, or 60 degrees, take it at two or more times, as you find most convenient. And if it be more than a semi-circle, distinguish it in your field book with this mark $>$, but if less with this mark $<$.— When the angle to be taken is greater than a semi-circle, it is best to take its supplement, and prefix the mark $<$, as above.

The method of expressing the quantity of an angle, is thus:—

Radius	100	=the measure of the angle
$<$ Chord	193	FAB.

Radius	100	
$<$ Chord	76	=the measure of the angle
	84	FAB.
	90	

To lay down this angle.

Draw AB at pleasure. Take 100 from a scale of equal parts, with which (and one foot of the compasses on A) describe the arc DG. Then (by the first method) set 193, taken from the same scale you used for the radius, from D to G, and draw AF; and (by the second method) set 76 from D to E, 84 from E to H, and 90 from H to G. Through G draw the line AF, and BAF will be the angle required.

PROP. III.

To measure a triangle.

Rule.

Measure the three sides, and set them down separately in your field book.

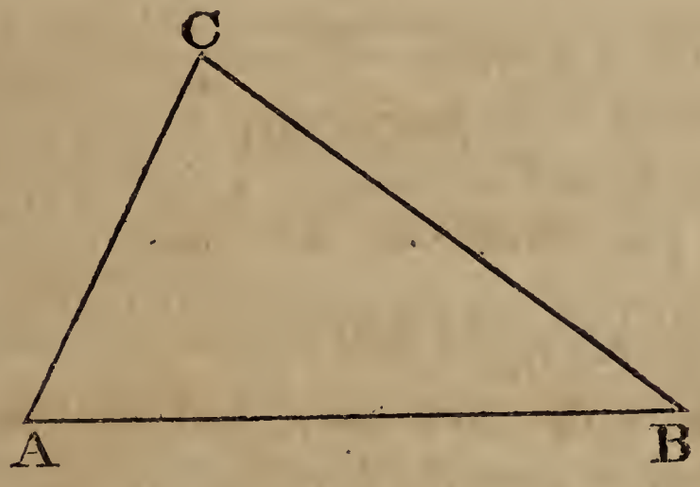
To cast up the same.—Add the three sides together, and take half their sum: Then subtract each side severally from the half sum, and multiply this half sum and the three remainders continually together: The square root of this last product will be the area. Or having drawn the plan; take (in your compasses) the nearest distance between the verticle angle and the

base, which apply to the scale from which you drew the figure, and it will shew the perpendicular. Then find the area as in the following proposition.

EXAMPLE.

Let ABC be a plain triangle, whose sides AB, BC, and CA, are found, by admeasurement, to be 1141, 1056, and 711 links respectively; required its plan and area?

I. By Geometry.



II. Calculation.

First, $\frac{1141+1056+711}{2}=\frac{2908}{2}=1454=\frac{1}{2}$ sum of the sides.

Then 1454—1141=313=the first difference; 1454—1056=398=the second difference; and 1454—711=743=the third difference.

Whence,

$\sqrt{1454\times313\times398\times743} = \sqrt{134580038280} =$ 366851 square links = 3·66851 acres = 3A. 2R. 26P. = the area.

PROP. IV.

*To measure a triangular field with the chain and cross.**

RULE.

For the dimensions.—Having set up marks at the corners of the field, begin at one of them—suppose A, and measure in a right line towards B, till you think you are come near to the point D, where a perpendicular will fall from the angle C; then letting the chain lie in the line AB, stick down the cross close to the side of the chain, and so as to see through one of the slits, or sights, the mark at A or B; then look

* Cross, in surveying, is an instrument consisting of a brass circle, divided into four equal parts, by two lines, crossing each other in the centre. At each extremity of these lines is fixed a perpendicular sight, with small holes below each slit, for the better observing of distant objects. The cross is mounted on a staff, to fix it in the ground, and is sometimes used in measuring small pieces of land, and taking offsets.

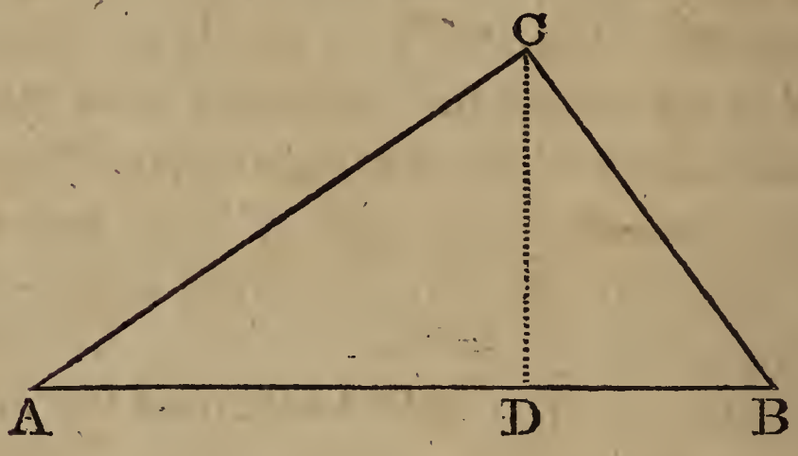
through the other slit, or sight, for the angle C, and observe whether it falls short, cuts, or falls beyond the said angle C. If it falls short, move forwards; if beyond, move backwards; till, by a few trials, you find the exact point D, where the cross being struck down, you can, through one of the slits, or sights, see the white B, and through the other the white or mark C. Observe how many chains and links this point D is from A: Then let your assistant, leaving a mark at the end of the last chain, turn towards C, and measure the perpendicular DC; and having entered it in your field book, and given your assistant the arrows, return and measure the remainder of the base, or line, AB, which also enter in your field book, and the dimensions are finished.

To cast up the same.—Multiply half the base by the perpendicular, or the whole base by half the perpendicular, and the product will be the area. Or multiply the base by the perpendicular height, and half the product will be the area.

EXAMPLE.

Having obtained the dimensions of a triangular field, as before directed,—AD is 500 links, the perpendicular DC is 334 links, and the whole base AB is 760 links; required its plan and area?

I. By Geometry.



II. Calculation.

Here $\frac{334 \times 760}{2} = \frac{253840}{2} = 126920$ links, or 1A. 1R. 3P.=the area.

PROP. V.

To measure a square.

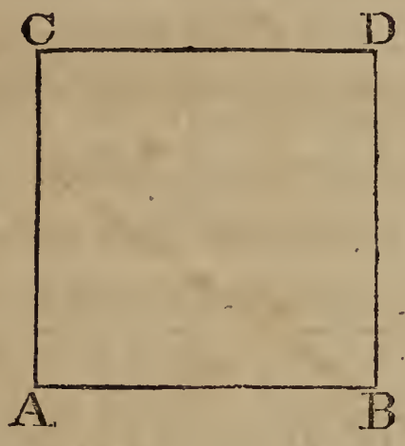
Rule.

Measure one of its sides, which multiply into itself for the area.

EXAMPLE.

Required the plan and area of square ABCD, whose side AB is 670 links?

I. By Geometry.



II. Calculation.

Here $670 \times 670 = 448900$ links, or 4A. 1R. 38P. = the area.

PROP. VI.

To measure a parallelogram.

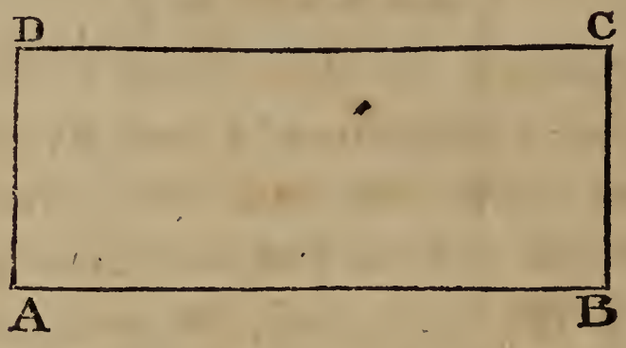
Rule.

Measure the length and breadth, then multiply the one by the other for the area.

EXAMPLE.

Required the plan and area of a field in form of a parallelogram, whose length AB is 600 links, and breadth AD 250 links?

I. Geometrically as per Figure.



II. Calculation.

Here 600×250=150000 links, or 1A. 2R.= the area.

PROP. VII.

To measure a trapezium.

Rule.

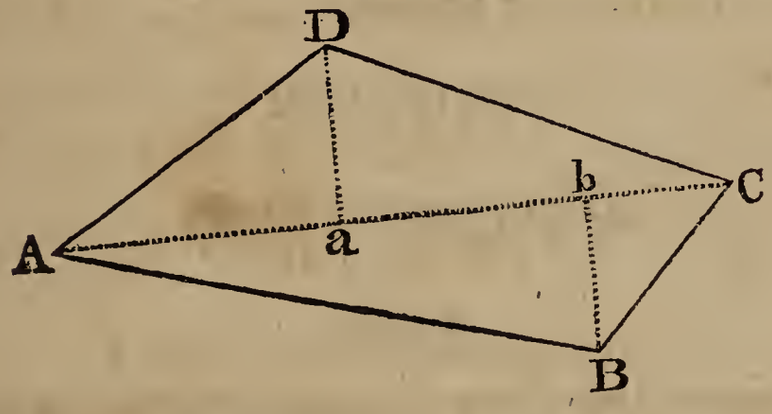
Begin at the corner A, and measure from thence to *a*, where raise the perpendicular *a*D. Then return to *a*, and measure from *a* to *b*, where let fall the perpendicular *b*B, and measure from *b* to B. This done, return to *b*, and mea-

sure from *b* to C, and the dimensions will be taken.

To cast up the same.—Add the two perpendiculars together, and take half their sum, which half sum multiply by the diagonal, and the product will be the area.

EXAMPLE.

Having taken the dimensions of a field, in the form of a trapezium, I find by my field-book, that A*a* is 380 links, the perpendicular *a*D is 250 links, A*b* is 712 links, the perpendicular *b*B is 190 links, and the diagonal AC is 920 links; required its plan and area?



I. To draw the Plan.

Draw the obscure line AC=920 links. Set off 380 links from A to *a*, and upon that point erect the perpendicular *a*D=250 links. Then set off 712 links from the beginning of the obscure line, that is, from the point A to *b*, and let

fall the perpendicular bB = 190 links. This done, join with black lines the ends of the obscure line and the perpendicular points, that is, draw AB, BC, CD, and DA, and the plan is finished.

II. Calculation.

Here $(250+190\div2)\times920=220\times920=202400$ links, or 2A. 0R. 3P. = the area.

Note.—When perpendiculars are not taken in the field, each side and diagonal of the trapezium must be measured; by which the figure may be easily drawn, and the content found, as per rule, by taking the perpendiculars from the scale by which you drew the plan.

PROP. VIII.

To measure a circle.

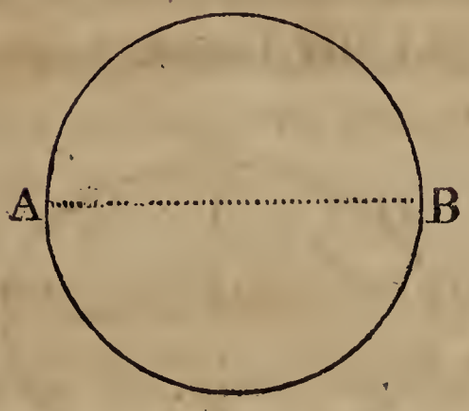
Rule.

Measure the diameter, square the diameter, and multiply that square by ·7854 for the area.

EXAMPLE.

There is a circular park, the diameter of which is 13 chains; required its plan and area?

I. By Geometry.



II. Calculation.

Here $1300^2 \times \cdot 7854 = 1300 \times 1300 \times \cdot 7854 = 1690000 \times \cdot 7854 = 1323326$ links $= 13$A. 0R. 37P. = the area.

PROP. IX.

To measure an ellipsis.

Rule.

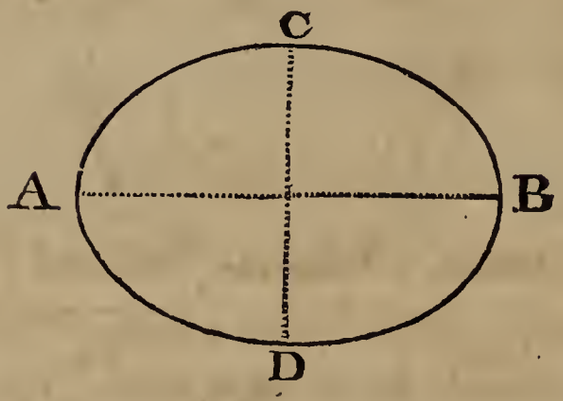
Measure the transverse and conjugate diameters; multiply them together, and their product by ·7854 for the area.

EXAMPLE.

A gentleman has an elliptic fish-pond, whose transverse diameter AB is 740 links, and the

conjugate CD 550 links; required its plan and area?

I. By Geometry.



II. Calculation.

Here $740 \times 550 \times .7854 = 407000 \times .7854 =$ 319657 links, or 3A. 0R. 31P. = the area.

PROP. X.

To measure any curve-lined space.

Rule.

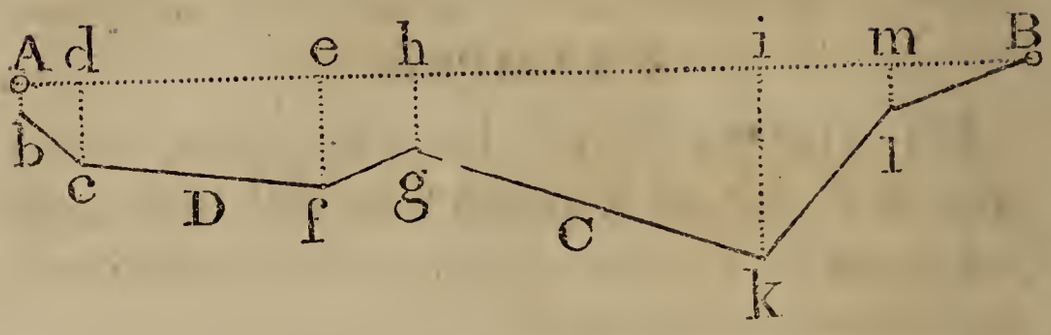
Measure in a right line from one end of the curve to the other, and, as often as you think convenient, take perpendiculars or offsets from the station line to the curve. Then multiply the sum of every two perpendiculars by the distance between them, and the sum of the products will be the double area.

EXAMPLE.

Let ABCDA be an irregular figure, whose plan and area are required from the dimensions subjoined.

FIELD BOOK.

Double areas	Off. left.	Station line.	Off. right.	Double areas
	From	A	To	B
		00	20	
		50	70	4500
		240	100	32300
		380	60	22400
		730	180	84000
		850	40	26400
		980	00	5200
			2	174800
				87400
				A. R P. =0 3 19 =the area



I. To draw the Plan.

Draw the station line AB, from which set off the perpendiculars, taken from the field book, viz. A*d*=20 links, *dc*=70 links, &c. at the respective distances upon the station line. Then through the several points *b*, *c*, *f*, &c. the curve may be delineated with a steady hand.

II. Calculation.

Here (20+70)×50=90×50=4500=double area of A*bcd*.

And (70+100)×240—50=170×190=32300 =double area of *dcfe*, &c.

Also (980—850)×40=130×40=5200=double area of *ml*B. Vide field book.

Note.—Sometimes such pieces as that above, are computed by finding a mean breadth, by dividing the sum of the offsets by the number of them, accounting that for one where the boundary meets the station line, as at B; then multiply the length AB, by that mean breadth, and the product will be the area. But this

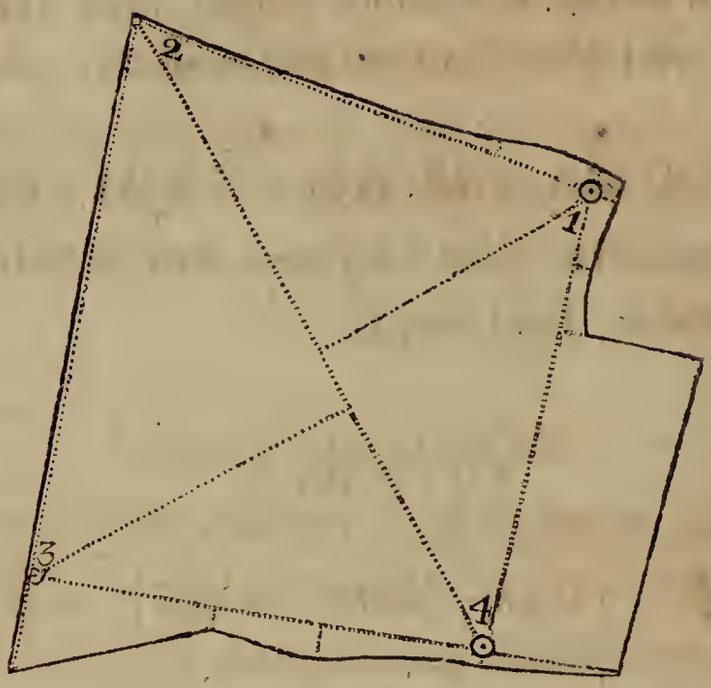
method is always erroneous, except when the offsets stand at equal distances from one another.

MISCELLANEOUS EXAMPLES.

I demand the plot and area of the field, from the following field book.

Field Book.

Remarks.	O. left.	Station.	O. right.	Remarks.
	From	No. 1 to	No. 2	
		00	40	
		160	20	
		345	00	
		780	No. 2	
	From	No. 2 to	No. 3	
		920	No. 3	
No. 3, produce by	No. 2	1080		
	From	No. 3 to	No. 4	
		305	40	
		480	60	
	No. 4	740	20	Leave off.
No. 4, produce by	No. 3	967		
	From	No. 4 to	No. 1	
		520	60	+180
		620	40	
	No. 1	744	50	
Diagonal	from	No. 2 to	No. 4	
		1142	No. 4	



I. To draw the Plan.

Draw the diagonal ⊙2, ⊙4, which make = 1142 links (taken from a scale of equal parts, suppose 5 chains to an inch), and with centre ⊙2, and radius = 780 links, describe an arc; then with centre ⊙4, and radius=744, describe another arc, cutting the former in ⊙1; join the points 2, 1, and 1, 4: and in the same manner (Geom. Prob. IX.) constitute the triangle 2, 3, 4, upon the other side of the diagonal, with the respective sides taken from the field book. Then upon ⊙3, produced by ⊙2, lay off 1080 links, = the distance between ⊙2, and corner, as appears in the field book; and upon ⊙4, produced by ⊙3, lay off 967 links, = the dis-

tance between ⊙3 and corner. Now take the offsets from the field book, and set them up (Prop. XI.) upon the respective station lines, and at the respective distances: then draw the lines (as in the above figure) and the field will be plotted.

II. Calculation.

Having dropt perpendiculars from the angular points No. 1, 3, upon the diagonal No. 2, 4, and applied them to the scale from which the plan was drawn, there will be found perp. No. 1=500 links, and perp. No. 3=580 links.

Then,

SQUARE LINKS.

40+ 20× 160= 60× 160= 9600 = double area of the 1st trapezoid.

20+ 00× 185= 20× 185= 3700 = double area of the 2d.

160+ 40× 305= 200× 305= 61000 = double area of the 3d.

40+ 60× 175= 100× 175= 17500 = double area of the 4th.

60+ 20× 260= 80× 260= 20800 = double area of the 5th.

20+ 00× 227= 20× 227= 4540 = double area of the 6th.

SQUARE LINKS.

227+240× 520= 467× 520=242840 = double area of the 7th.

60+ 40× 100= 100× 100= 10000 = double area of the 8th.

40+ 50× 124= 90× 124= 11160 = double area of the 9th.

40× 50× 2= 40× 100= 4000 = double area of the parallelogram No. 1.

580+500×1142=1080×1142=1233360 = double area of the trapezium No. 1, 2, 3, 4.

TOTAL

2)1618500

8·09250
4

·37000
40

14·80000

Area, 8A. 0R. 15P. nearly.

Observe.—1. The parts contained between the traverse lines and the hedges are reckoned trapezoides, and their several areas found as shewn in Prop. XI.

2. The corner, No. 1, is considered as a small square or parallelogram, and its area is found by multiplying the first and last offsets together. Prop. VII.

3. The part, No. 1, 2, 3, 4, is a large trapezium, and its area is found accordingly. Prop. VIII.—And thus the double areas of all the articles being obtained, the remainder of the work is managed as on the other side.

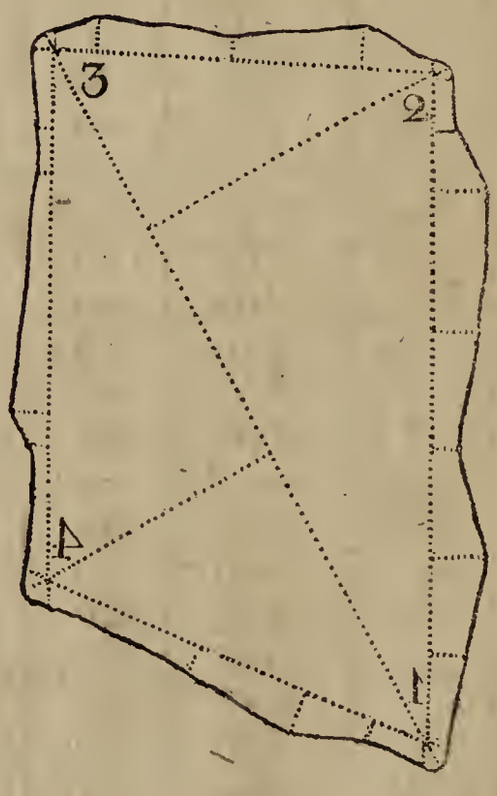
Required the plot and area of the figure from the following field book.

Remarks.	Left.	Station.	Right.	Remarks.
From	No.	1 to	No.	2
		00	20	
		130	50	
		245	75	
		390	30	
		550	55	
		740	70	
		820	30	
No.	2	875	25	Corner 25*
From	No.	2 to	No.	3
		00	20	
		100	50	
		270	30	
		450	45	
No.	3	500	25	Corner 30
From	No.	3 to	No.	4
		00	30	
		100	20	
		160	20	
		470	50	
		500	20	
No.	4	685	25	Corner 35

* It is often of advantage to take a diagonal offset to the corner, in order to delineate the junction of the hedges more accurately.

Remarks.	Left.	Station.	Right.	Remarks.
From	No.	4 to	No.	1
		00	30	
		330	50	
		450	30	
No.	1	545	20	Corner 30
Diagonal	from	No. 1 to	No.	3
Perp. No. 4	330	435		
		770	422	Perp. No. 2
No.	3	1030		

I. Plan.



II. Calculation.

	DOUBLE AREAS.
From No. 1 to No. 2, - -	87700
From No. 2 to No. 3, - -	38350
From No. 3 to No. 4, - -	40400
From No. 4 to No. 1, - -	41350
Trapezium 1, 2, 3, 4, - -	774560
	2) 982360
	4·91180
	4
	3·64720
	40
4A. 3R. 25P.—the content.	25·88800

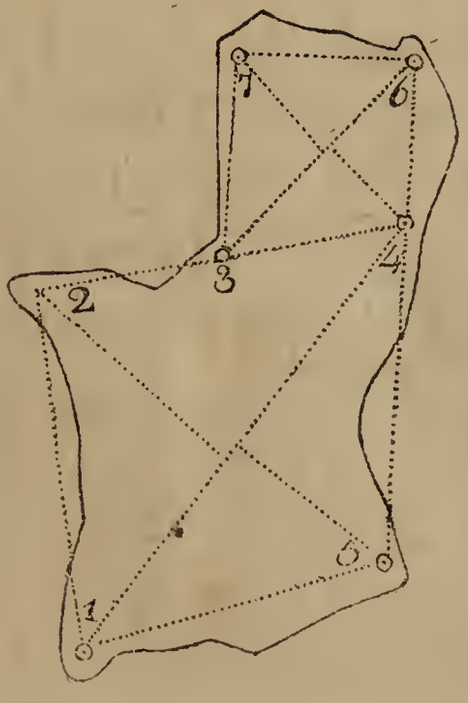
I demand the plan and area of the following field, from the following field book.

Remarks.	Left.	Station.	Right.	Remarks.
From	No.	1 to	No.	2
	25	00		
	15	50		
	00	120		Cross the hedge into the open ground.
		170	20	
		340	35	
		400	10	Cross the hedge into the field again.
		430	00	
Corner 25	15	460	at	No. 2

Remarks.	Left.	Station.	Right.	Remarks.
From	No.	2 to	No.	4
	20	00		
	10	100		
	00	120		Cross the hedge into the open ground.
		170	30	
		190	00	Cross the hedge into the field again.
	15	220		
	20	250	at	No. 3
	00	490	No.	4
From	No.	4 to	No.	5
	20	00		
	10	100		
	00	150		Cross the hedge into the open ground.
		220	30	
		270	50	
		320	25	
		400	00	Cross the hedge into the field again.
	10	420		
Corner 25	20	450	at	No. 5
From	No.	5 to	No.	1
	70	200		
	40	250		
	30	300		
	20	380		
	10	390		
Corner 20	15	415		
Diagonal	from	No. 1	to	No. 4
No. 2.	310	330		
		340	240	No. 5
		725	at	No. 4
From	No.	4 to	No.	6
		00	20	

Remarks.	Left.	Station.	Right.	Remarks.
		100	50	
		180	40	
No. 6.		205	20	Corner 30
From	No.	6 to	No.	7
		00	20	
		100	30	
		200	50	
No. 7		240	30	Corner 40
From	No.	7 to	No.	3
		00	20	
		260	at	No. 3
From	No.	3 to	No.	6
No. 7	180	180		
		190	130	No. 4
at No.	6	355		

I. Plan.



II. Calculation.

	ADD.	DEDUCT.
From No. 1 to No. 2=	3875	13350
From No. 2 to No. 3=	5200	2100
From No. 4 to No. 5=	5100	11850
From No. 5 to No. 1=	30475	
From No. 4 to No. 6=	16300	
From No. 6 to No. 7=	18000	
From No. 7 to No. 3=	6000	
Trapezium 1, 2, 3, 4=	398750	
Trapezium 3, 4, 6, 7=	110050	
	593750	27300
	27300	
	2)566450	
	2·83225	
	4	
	3·33000	
	40	
	13·20000	

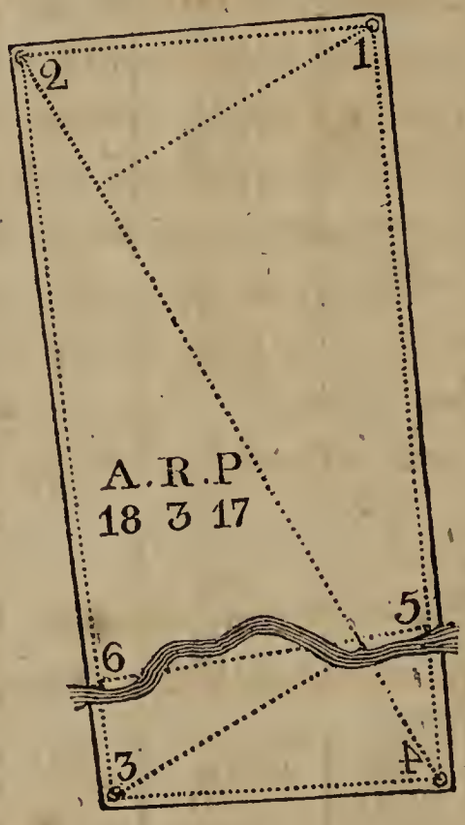
2R. 3A. 13P.—content.

I demand the plan and area of the field from the following field book, as taken with the chain and cross.

Remarks.	Left.	Station.	Right.	Remarks.
From	No.	1 to	No.	2
		00	20	
No. 2		907	21	Corner 28
From	No.	2 to	No.	3
		00	14	
		1650	No.	6
		1675		Burn
		1680		Cross the burn
No. 3		1973	24	Corner 32
From	No.	3 to	No.	4
		00	24	
No. 4		868	30	Corner 32
From	No.	4 to	No.	1
		00	18	
		360		Burn
		380		Cross the burn
		400	No.	5
Corner 22		2013	14	No. 1
Diagonal	from	No. 2	to	No. 4
No. 1	832	370		
		1800	786	No. 3
		2190	No.	4
From	No.	5 to	No.	No. 6
Burn	40	200		
B.		310		
Cross the burn		325		
		360	20	Burn
		450	80	B.

Remarks.	Left.	Station.	Right.	Remarks.
		500	10	B.
		600	60	B.
		710	40	B.
		750		B.
		770	Cross	B.
B.	5	800		
		884	No.	6

I. Plan.



II. Calculation.

From No. 1 to No. 2, - -	28705
From No. 2 to No. 3, - -	76134
From No. 3 to No. 4, - -	48630
From No. 4 to No. 1, - -	65312
Trapezium 1, 2, 3, 4, - -	3543420

TOTAL.

2) 3772201

18·861005

4

3·44402

40

17·76080

Observe.—Although the hedges are straight in the above figure, yet in the actual survey it was not convenient to keep close to them;—which was likewise the case in some of the other articles.—And wherever the cross is not particularly mentioned, the perpendiculars, &c. were taken from the plan, notwithstanding their being introduced into the field book.

N. B. This last method is less objectionable, on account of the great difficulty of fixing the instrument correctly.

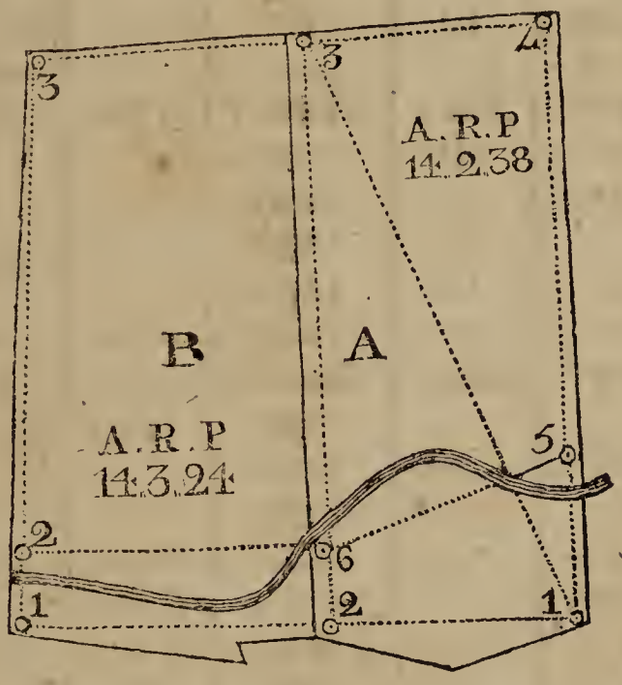
I demand the plot and area of the following fields, from the following field book.

Remarks.	Left.	Station.	Right.	Remarks.
From	No. 1	Field A	to No.	1 Field B.
	22	00		
	82	275		
No. 2	in A	764		
	20	785		Cross the hedge into field B.
	22	1000		
	48	1000		
Corner 18	11	1666	No. 1	A

Remarks.	Left.	Station.	Right.	Remarks.
From	No. 15	1 Field B 00	to No.	3
		53		Pont
West side of the gap	15	80		Cross P.
		85	No. 2	Field B
Corner 24	18	1712	No. 3	B
From	No. 17	3 B 00	to No.	4 A
Cross into Field A		735		
No. 3 A		754		
Corner 20	14	1364	No. 4	A
From	No. 15	4 to 00	No. 1	A
No. 5		1500		
		1550	P.	
Corner 28	24	1570		Cross Pont
		2041	No. 1	A
Diagonal No. 3	No.	1 to 2133	No. 3 Field	A A
From	No.	3 to 1600	No. 2 at	A Pont.
		1632		Cross Pont
		1665	No.	6
		1895	No.	2
From	No.	2 B to 200	No. 68	6 Pont
		486	96	P.
		680	128	P.
		700	140	P.
		830	P.	
		854		Cross P.
		889	No. 6	A

Remarks.	Left.	Station.	Right.	Remarks.
From Pont	No. 120	6 to 200	No.	5 A
		400		Pont
		430		Cross P.
		520	82	P.
		753		No. 5 A.

PLAN, &c.



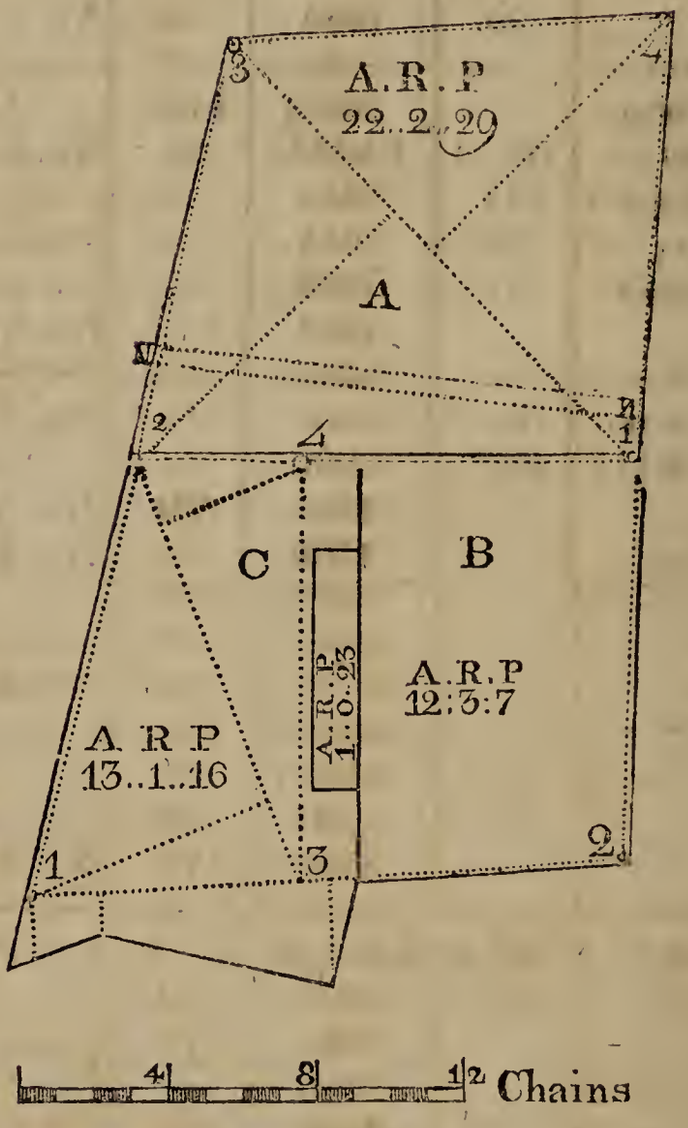
Required the plan and area of the following fields from the following field book, as taken with the chain and cross.

Remarks.	Left.	Station.	Right.	Remarks.
From	No. 1	Field B 00	to No. 15	2 Field C
		962		Cross the hedge into field C
		1100		No. 4 Field C
		1646	20	No. 2 Field C

Remarks.	Left.	Station.	Right.	Remarks.
From	No. 2	Field C	to No.	3 Field A
	25	00		
		20		Cross the hedge into Field A
		300		Turnpike
		330		Cross the Turnpike
	12	1400		No. 3 Field A
From	No. 3	Field A	to No.	4 Field A
	15	00		
	10	1480		No. 4 Field A
From	No. 4	Field A	to No.	1 Feld B
	10	00		
		1290		Turnpike
		1320		Cross the Turnpike
	10	1520		No. 1
Diag. from	No. 1	Field B	to No.	3 Field A
		992	1120	No. 4 Field A
No. 2 Field C	1166	1170		
		1950		No. 3
Return to		No. 1	Field	B
From	No. 1	Field B	to No.	2 Field B
	15	00		
	15	1313		No. 2 Field B
From	No. 2	Field B	to No.	1 Field C
	20	00		
	12	860		
		873		Cross the hedge into field C
	330	940		
		1010		No. 3 Field C
	85	1755		
	180	1904		No. 1.
From	No. 1	Field C	to No.	2 Field C

Remarks.	Left.	Station.	Right.	Remarks.
	10	00		
	25	1484		No. 2 Field C
Return to		No. 4	Field	C
From	No. 4	Field C	to	No. 3 Field C
Cor. Nursery	144	245		
Nursery	10	255		
N. W. Corner	15	1080		
		1387		No. 3 Field C
Diag. from	No. 3	to		No. 2 Field C
No. 1 Field C	846	280		
		1295	504	No. 4 Field C
		1500		No. 2 Field C.

PLAN, &c.



I demand the plot and area of the following fields, from the following field book.

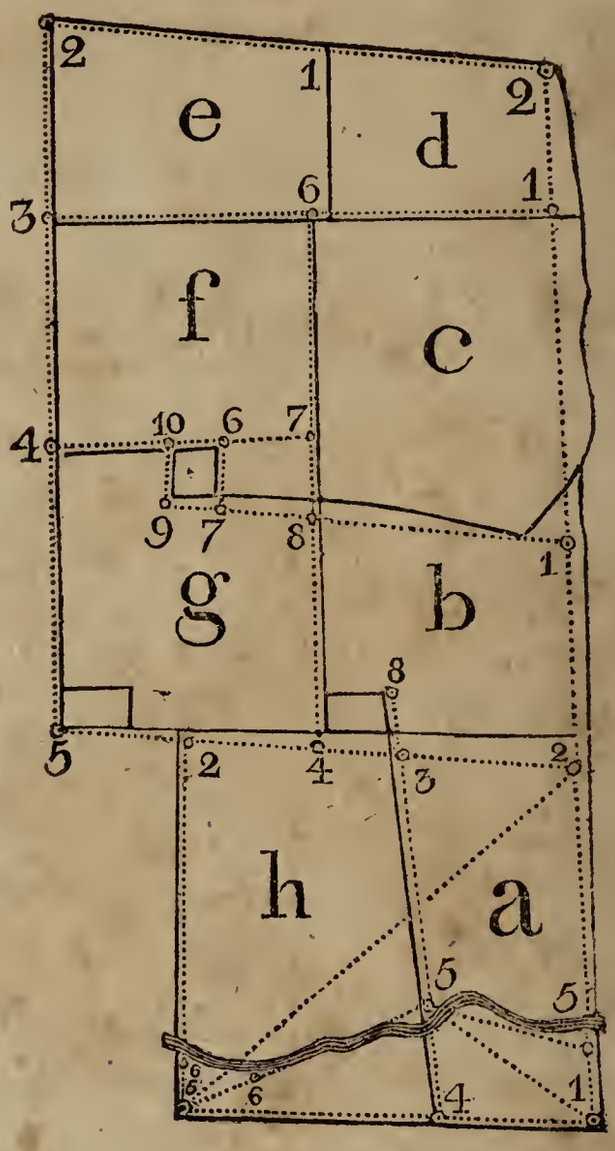
Remarks.	Left.	Station.	Right.	Remarks.
From	No. 1	Field A	to No.	2 Field D
		00	35	
		28	30	
		170	50	
		200		No. 5 on the Burn
		250	50	W. side of the gate
		1873		No. 2 Field A
		2030	15	Cross h. into Fd. B
		2950		No. 1 Field B
		3200	10	Cross the hedge into Field C
		3440	15	
		3535	85	
		3675	60	
		3790	50	
		4200	120	
		4280	100	Cross h. into Fd. D
		4300	10	No. 1 Field D
		4440	100	
		4700	120	
		4900	150	
		5360	10	No. 2 Field D
From	No. 2	Field D	to No.	2 Field E
		00	10	
		1025	15	Cross h. into Fd. E
		1045		No. 1 Field E
		2145	20	Cross h. out of Fd E
		2160		No. 2
From	No.	2	to	No. 5
	15	00		
		1360		No. 3
		2000		Gate
		2244		No. 4
	30	2262		
N. W. cor. nursery	20	3413		
S. W. cor. nursery		3548		No. 5

Remarks.	Left.	Station.	Right.	Remarks.
From	No. 5	to	No. 2	Field A
	40	25		
S. E. cor. nursery	20	490		
		647		No. 2 Field H
	30	1250		
		1560		Cross h. into Fd. A
		1580		No. 3 Field A
		2495		No. 2 Field A
Return to	No. 1	Field A to	No. 5	Field H
	35	00		
		770		No. 4 Field A
	25	780		
W. side of the gate	20	1520		Cross the Burn
	20	1980		No. 5 Field H
From	No. 5	Field H	to	No. 2
	15	00		
No. 6 Field H		300		
		330		Cross Burn
No. 5 Field H	15	2062		
Diagonal	from	No. 5 Fd. H	to No.	2 Field A
		235		No. 6
		280		Burn
		1470		Cross h. into Fd. A
		2698		No. 2 Field A
From	No. 4	Field A	to No.	3 Field A
	10	00		
		295		Burn
		335	Cross B.	No. 5 Field A
		1968		No. 3 Field A
Continued to No. 8	Field B	1978		Cross h. into Fd. B
S. E. cor. nursery	10	2010		
N. E. cor. nursery	10	2165		No. 8 Field B

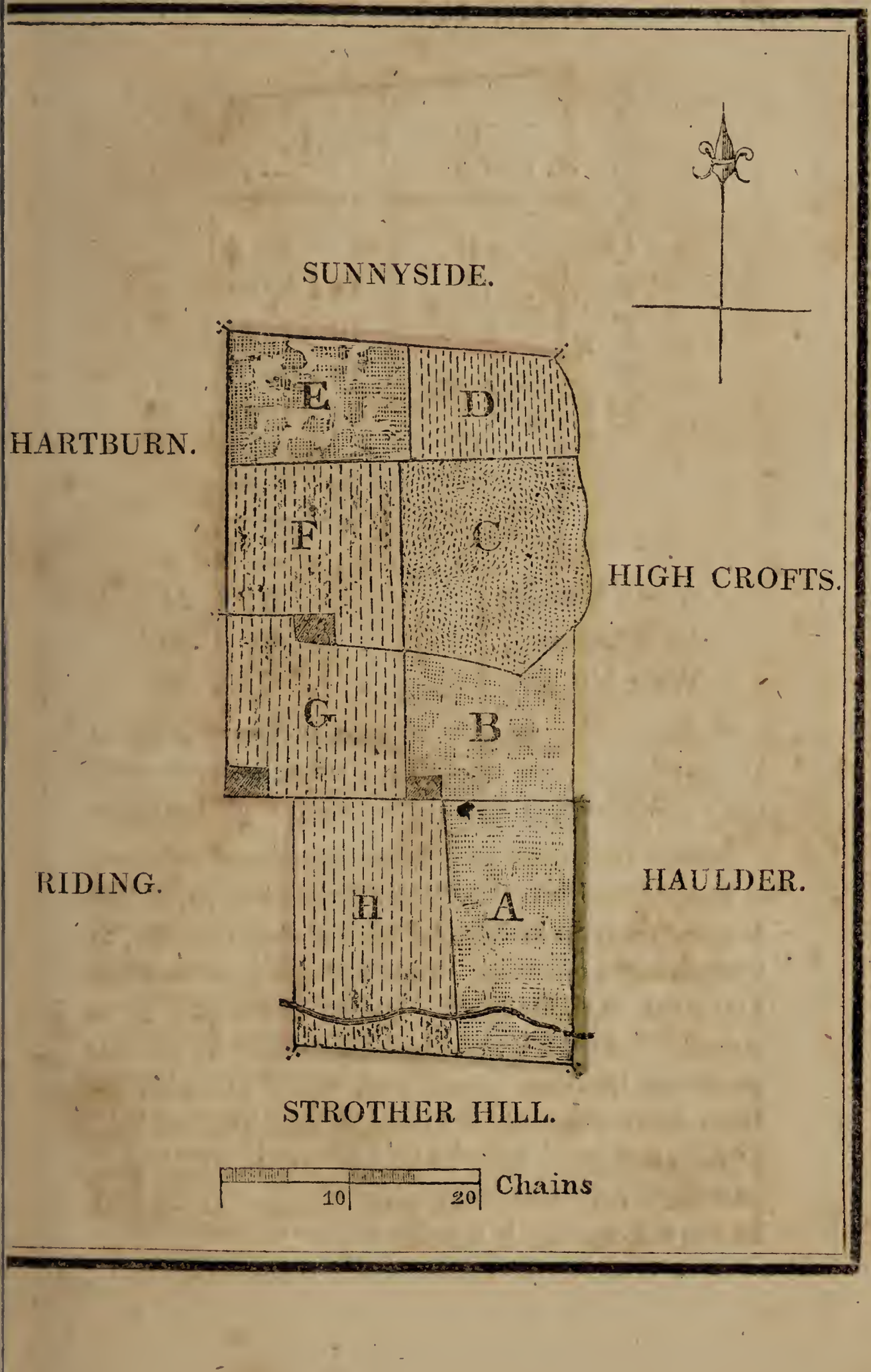
Remarks.	Left.	Station.	Right.	Remarks.
From No. 6 on	Burn 20	to No. 6 00 208	on	Diag. Burn No. 6
From	No. 6	Field H 00 60 160 250 300 360 400 475 550 860 1043	to No. 45 60 80 100 120 100 150 50	5 Field A Cross Burn B. B. B. B. B. B. B. B. No. 5 Field A
From No. 5 B. B. B. B. B. B. 	Field A 45 30 80 45 100 30 40	to No. 130 190 240 300 400 580 700 800 897	5 Field A on the Burn	Cross the Burn No. 5 Field A
From	No. 1 20	Field D 1085 1186 2242	to No.	3 Field A No. 6 Field E No. 3
Return to a Gate	No. 6 10 8 5	Field E 15 600 900	to No.	4 Field H

Remarks.	Left.	Station.	Right.	Remarks.
		1155		Cross h. into Fd. G
	8	1172		No. 8 Field G
N. W. cor. nursery	10	2155		
S. W. cor. nursery	10	2285		Cross h. into Fd. H
		2317		No. 4 Field H
Return to	No. 1	Field B	to No.	8 Field H.
		515	15	
		1215		
		1222		No. 8 Field G
Contd. to Field G		1635		No. 7 Field G
No. 9		1960		
Return	to	No. 4	to No.	7 Field F
	26	13		Cross h. into Fd. F
		370	20	a Gate
		400		No. 10 Field F
N. E. cor. nursery		685	20	
		700		No. 6 Field F
No. 7 Field F		1152		
Return to	No. 6	Field F to	No. 7	Field G
		20	15	N. E. cor. nursery
Cross. h. into Fd G		200	10	S. E. cor. nursery
		229		No. 7 Field G
Return to	No. 9	Field G to	No. 10	Field F
		60	25	S. W. cor. nursery
		170	15	N. W. cor. nursery
		188		No. 10 Field F





Note.—The rough plan being compleated as above, it may be transferred by laying it on clean paper, and keeping them always pressed flat and close together, by weights laid upon them. Then with the point of a fine pin, prick through all the corners of the plan to be copied. Take them asunder, and connect the pricked points on the clean paper, with lines: Or, with the blunt point of some hard substance, trace over the lines of the whole plan; after which take off the rough plan, and trace over the marks with common ink, or with Indian ink, &c. and it is done.


SUNNYSIDE.
HARTBURN.
HIGH CROFTS.
RIDING.
HAULDER.
STROTHER HILL.
E
D
F
C
G
B
H
A
10
20
Chains

	A.	R.	P.
A	18	3	0
B	13	1	15
C	14	1	20
D	13	2	2
E	14	3	28
F	10	1	20
G	14	0	0
H	21	1	31
	120	2	36

	A.	R.	P.
North Nursery, ...	0	1	24
East Nursery, ...	0	1	20
West Nursery, ...	0	2	29

Note.—1. The content of each inclosure is found by dividing it into trapeziums, triangles, and curve spaces, and casting up, as the nature of the figure requires.

2. In casting up, surveyors sometimes use the method of give and take, by which each field is reduced to one regular figure; but this is liable to great error, unless a keen eye be accompanied with considerable practice.

3. It is a good method to prove the work frequently, by making choice of one or more objects in the survey. These being placed (in the plan) in their due positions, they are compared with the field book, by measuring to them from particular stations;—and so it is found how the work goes on. If it does not prove, it must be re-measured.—A house or a tree makes a good object.

I demand the area and plot of the fields, from the following field book.

Remarks.	Left.	Station.	Right.	Remarks.
From		No. 1		in Field A
		00	110	
		25	110	
		35	20	Corner 20
		245	00	
		500	110	
		850	170	
		1250	150	
		1670	90	
		1750	90	
		1825	100	Corner Field A
No. 2 Field A		1870		
		1884		Cross h. into Fd, B
		2380		Cross Drain
		2442	120	Ditto
to Drain	250	2455		
No. 1 Field B		3190		
		3200	25	Corner Field B
		3255	25	End
		3275	00	Pont
		3295		Cross Do.
		3330	25	
		3640		No. 3 Field B
		3656		Cross D. into Fd B
		4885	110	and cor. Fd C
		4895		to No. 1 Fd C
Return to		No. 1		Field B
Corner Field B	10	20		
Corner 30	20	591	to	No. 2 Field B
		No. 2		Field B
	20	00		

Remarks.	Left.	Station.	Right.	Remarks.
		650		Cross Drain
	70	1237		
Corner Field B	100	1334		
		1345		Cross h. into Fd. A
		1358	to	No. 2 Field A
		No. 2		Field A
		750	20	at a Gate
to No. 3 Fd. A		944	15	Corner 20
		No. 3		Field A
		00	15	
		890	20	and Stile
		2080	25	a Gate
to No. 4 Fd. A		2095	25	Corner 30
		No. 4		Field A
		00	20	
		48	20	
to No. 1 Fd. A		979	25	
Diag. from		No. 1		Field A
		2428	to	No. 3 Field A
		No. 3		Field A
		18	25	Corner Field D
Cross h. into Fd. D		375	25	a Gate
to No. 2 Fd. D		1007	15	Corner 25
		No. 2		Field D
		00	20	
to No. 1 Fd. D		1682	30	Corner 20
		No. 1		Field D
		00	20	
		1040		15 Corner
to No. 4 Fd. A		1066		

Remarks.	Left.	Station.	Right.	Remarks.
Return to	No. 3	Field A	Line	contd. from No. 4
		12		Cross h. into Fd. B
		734	End	
		742	No. 4	Field B
		795	Cross P.	to No. 5 Field B
		No. 4		Field B
Pont	00	50		
Cross P.	30			
P.	00	100		
Cross P.	40			
Cross P.	50	150	10	Pont Cartway
P.	00	200		
Cross P.	30			
P.	20	300		
Cross P.	50			
P.	30	400		
Cross P.	80			
P.	30	440		
Cross P.	50			
P.	00	537	to	No. 3 Field A
Cross P.	20			
		No. 3		Field B
Pont	20	35		
Cross P.	30			
P.	40	100		
Cross P.	60			
P.	70	150		
Cross P.	90			
P.	60	200		
Cross P.	80			
		376	to	No. 1 Field B
Return to		No. 5		Field B
		240		No. 6 Field B

Remarks.	Left.	Station.	Right.	Remarks.
A Gate	25	270		Cross h. into E
Pont	60			
Cross P.	90			
P.	90	550		
Cross P.	120			
P.	90	633		
Cross P.	130			
P.	80	730		
Cross P.	110			
P.	60	840		
Cross P.	120			
P.	50	900		
Cross P.	120			
		1048	to	No. 1 Field E
		No. 1		Field E
		00	30	
		15	30	Pont
		60	30	P.
		60	20	
		575	20	
		592	to	No. 2 Field D
Return to		No. 6		Field B
		575		No. 7 Field B
		597		Cross Drain
		1770	to	No. 2 Field C
		No. 2		Field C
	20	00		
	25	1188	to	No. 1 Field C
Return to		No. 2		Field E
Gate		30	25	Corner
		760	15	Gate
to No. 2 Fd. E		1040	20	

Remarks.	Left.	Station.	Right.	Remarks.
		No. 2		Field E
		1200		No. 3
		1380		No. 4
		2020	to	No. 1 Field E
		No. 1		Field E
	20	22		
	20	440		
Well	90			
		567	to	No. 5 Field E
Continued	to	No. 4		Field F
Corner	15	580		Cross h. into Fd. F
to further Corner	60			
Pont		640		
		850	50	P.
		1166		No. 4 Field F
Return to		No. 5		Field E
		629		No. 6 in do.
Corner	15	670	Cross	wall to Stackyard
Corner	15	800	Cross	wall do. to Field E
		807		No. 7
Gate	15	815		
	15	990		
		1010		
		1967	to	No. 2 Field E
Return to		No. 7		Field E
		115	10	Gate
		228	15	Cor. Stackyard
		231	60	Cor. do. and Stable
		318	65	Cor. Milk House
		339	to	No. 3 Field E
		No. 4		Field E
		90	20	S. E. cor. house
		120	22	S. W. do.
			80	to Byer

Remarks.	Left.	Station.	Right.	Remarks.
		203	30	S. W. cor. Barn
		389		to No. 6 Fd. E
		No. 2		Field E
		10	20	
to No. 1 Fd. G		1145	30	Corner
		No. 1		Field G
		00	20	
		45	50	
		155	50	
		261	60	
		340	80	
S. Bound. Cook		366	105	
		420	130	
		540	65	
		600	50	
to No. 2 Fd. G		668	50	
Produce No. 2	Field G	to	No. 7	Field E
		No. 2	Field	G
Cross h. into Fd. F		20	50	Corner Field
Bell's South Bound.		70	100	
		170	150	
		190	170	
		255	230	
		540	40	
		600	30	
		635	60	
		660	130	
		800	70	
		860	80	
		938		Cross P. into Chicken's
	55	980		
	50	1021		
	45	1055		
	120	1110		
		1210		to No. 4 Fd. F.

SURVEYING by the CHAIN



A Plan of DEWLAW 1809

Mr Robert Dunn

Road from Great Whittington to West Matfen

A.R.P. 8.3.17 G

A.R.P. 9.2.24 F

E A.R.P. 28.1.15

C A.R.P. 20.2.17

B

A.R.P. 18.1.5 B

A.R.P. 18.3.3 D

A.R.P. 20.2.8 A

E

Clay Banks

Barn

Hill

ook's

ell's

hickin's

larewood

Road from Great Whittington to Newcastle

Standing Stone

8 16 Chains

I demand the plan and area of the following fields, from the following field book.

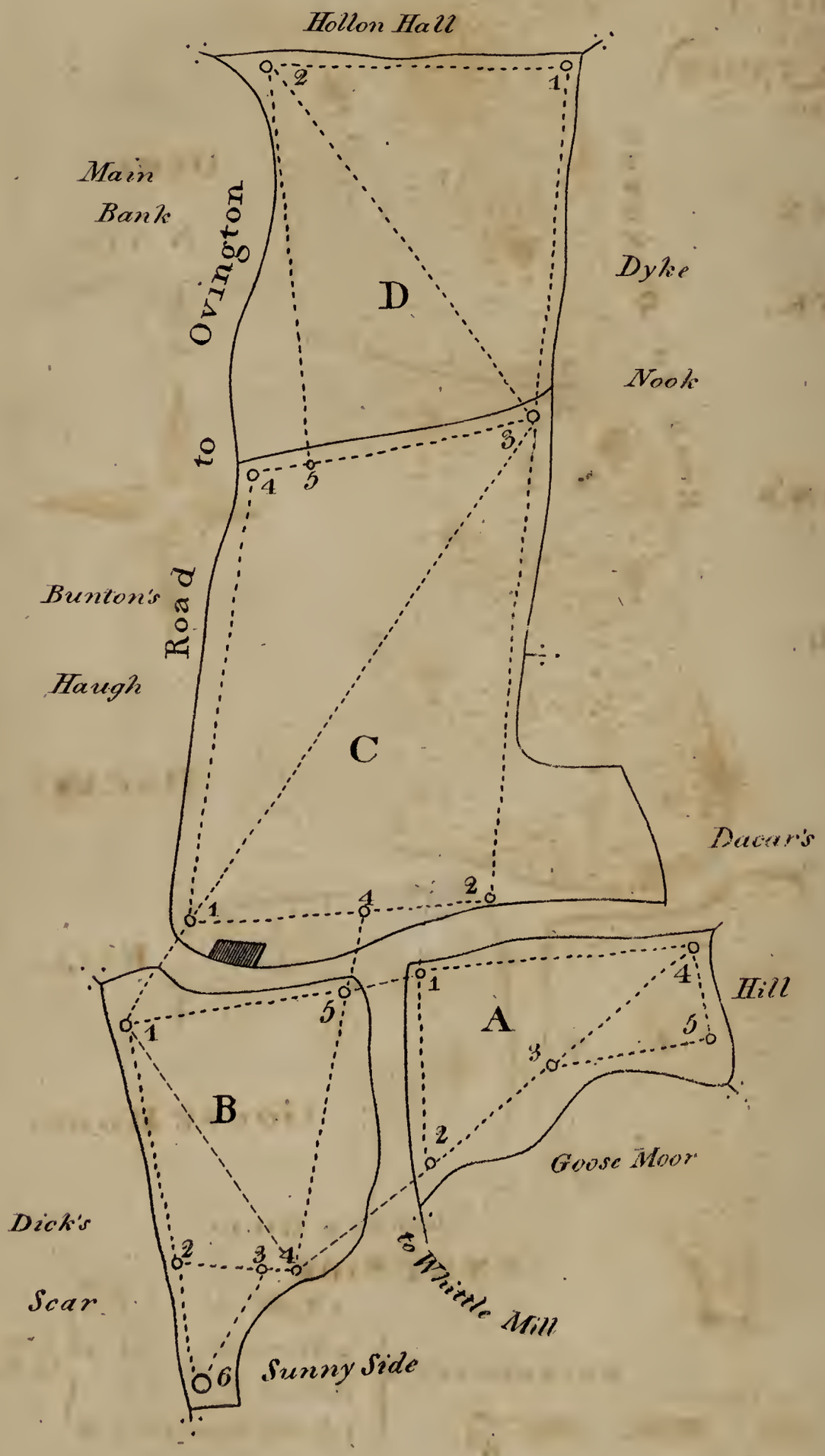
Remarks.	Left.	Station.	Right.	Remarks.
North From		Bank No. 1		Field A
		00	10	
		150	10	
		275	00	
		300	00	
to No. 2		380	20	Corner 30
		No. 2		
		00	00	
		60	20	
		165	80	
		300		at No. 3
		642		to No. 4
		No. 4		
		00	00	
		160	10	
		472	10	to No. 1
		No. 3		
		30	50	
		130	30	
		220	40	
to No. 5		291	90	Corner
		No. 5		
		00	10	
		180	10	and Corner
South		Bank No. 1		Field B
		00	10	

Remarks.	Left.	Station.	Right.	Remarks.
		200	15	
to No. 2		418	10	
		No. 2		
		200		No. 3
		225	30	
		255		to No. 4
		No. 4		
		00	10	
		100	60	
		220	70	
		340	50	
		440	30	
to No. 5		494	10	
		No. 5		
		00	10	
		210	10	
		260	30	
		290	50	
		325	90	
		400	90	
		403		to No. 1
Diagonal	from	No. 1		to No. 4
		530		No. 4
		No. 3		
	30	30		
	10	100		
	20	150		
	30	180		
	40	200		
Corner 10	10	248		to No. 6
		No. 6		

Remarks.	Left.	Station.	Right.	Remarks.
	10	00		
		180		to No. 2
Barn		Field C		
		No. 1		
		00	10	
		25	30	Corner Barn
		34	10	Barn
		110	45	Do.
		110	70	
		110	75	Corner Barn
		310	45	Lane.
		538	10	to No. 2
		No. 2		
		00	290	Corner Field
		235	189	Corner Field
		240	20	
to No. 3		848	20	Corner 20
		No. 3		
		00	10	
		300	15	
		422		No. 5
to No. 4		525	10	Corner 10
		No. 4		
		00	10	
		100	15	
		190	40	
		300	30	
		600	20	
to No. 1		807	10	Corner 70
Diag. from		No. 1		to No. 3
		1199		No. 3

Remarks.	Left.	Station.	Right.	Remarks.
		No. 3		in Barn Field
		15		Cross h. into W. Fd
		100	15	
to No. 1 West	Field D	595	15	Corner 20
		No. 1		
		00	20	
		290	15	
to No. 2		531	20	Corner 70
		No. 2		
		90	20	
		180	25	
		260	20	
		430	50	
		676		to No. 5
Diag. from		No. 3		to No. 2
		736		No. 2
		No. 2		Field A
No. 2 produce by	No. 4	280		to No. 4 Fd B
		No. 1		Field A
		130		to No. 5 Fd B
		No. 5		Field B
No. 5 produce by	No. 4	130	to No. 4	in the line 1, 2, Fd C
		No. 1		Field C
No. 1 produce by	No. 3	200		to No. 1 Fd B

SURVEYING by the CHAIN



A Plan of TOTHERTON 1809



REFERENCES	A. R. P.	A. R. P.
1 West Field	3. 1. 26	12. 0. 35
2 Barn Dº	5. 1. 4	
3 Bank Dº	1. 2. 3	
4 Little Meadow	2. 0. 2	

Scale of Chains

4 8

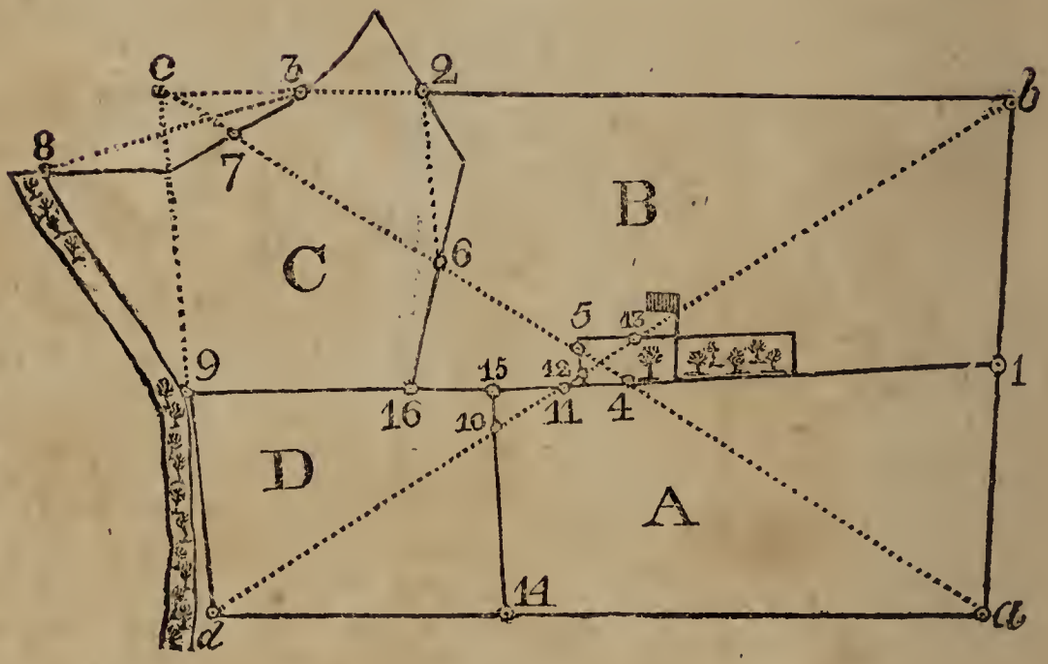
I demand the plot and area of the following fields, from the following field book.

Remarks.	Left.	Station.	Right.	Remarks.
From		a		
		85		Gate
No. 1		982	00	H. B. W.
		1690		to b
		b		
		38		Gate
N. W. cor. Field B		1700		H. B. S. No. 2
		1866	118	N. H.
N. E. corner		1866	241	Field C
Cor. Field C		1993		Cross N. H. No. 3
		2487		to c
		a		
No. 4		1432		Cross N. H. Fd. A
No. 5		1463		Cross W. H. Nur.
No. 6		2178		Cross W. H. Fd. B
No. 7		2888		Cross N. H. Fd. C
		3266		to c
		c		
No. 8		381		Cross N. H. Fd. C
Field C		431	245	N. W. Cor.
		559	200	W. H. Fd. C
Cross S. H. Field C	No. 9	1114	50	N. W. cor. Fd. D
		1210	27	W. H. Fd. D.
		1613	22	Ditto
		2020	15	End of Nursery
		2052		Gate
		2082		to d
		d		
No. 10		1324		E. H. Fd. D
No. 11		1587		Cross N. H. Fd. A

Remarks.	Left.	Station.	Right.	Remarks.
No. 12		1686		Cross W. H. Nur.
No. 13		1833		Cross N. H. Nur.
S. E. cor. Pond	20	1963		
S. W. cor. do.	87	1979		
		2026	10	S. E. cor. Pond
N. E. cor. Pond	55	2053		
		2991		to b
		a		
		1345		H. B. North No. 14
		2530		to d. Close here
		No. 1		
		25		Gate
North		265	130	H. B.
		805		Watercourse
		1065		to No. 4
		No. 4		
		22	130	H. B. N.
		107		to No. 11
		No. 11		
to No. 15		235		N. W. Cor. Field D
		No. 15		
		134		to No. 10
		No. 10		
Gate		731		
to No. 14		758		Close here Field A
		No. 15		
Gate	12	70		
No. 16		314		Hedge bears North
to No. 9		1074		Close here Field D

Remarks.	Left.	Station.	Right.	Remarks.
Gate		No. 16 350 491		to No. 6
to No. 2		No. 6 335 573	95	E. H. Field C Close here Field B
		No. 2 183 200 294	120 236	Near Corner Far Cor. to No. 3
to N. H. Field C to No. 8	55	No. 3 424 573		Close here Field C.

Eye Plan.



Remarks.	Left.	Station.	Right.	Remarks.
		C		
		272		No. 5
		370		Cross h. out of Fd D
No. 6		1301	60	
		1611	29	
No. 7		2321	40	
		2741		Cross h. into Fd. F
No. 8		3191	35	Leave off
		3941		to A
		A		
Cross B.	50-	00		
B.	81	130		
B.	143	249		
B.	124	325		
B.	100	370		
B.	79	430		
B.	36	480		
B.	20	569		
B.	00	640		to No. 9
Cross B.	50	640		
		No. 9		
B.	33	100		
B.	32	200		
B.	25	254		
B.	48	312		
B.	64	385		
B.	64	430		
B.	160	488		
B.	100	576		
B.	150	680		
B.	140	740		
B.	129	810		
B.	100	887		
B.	122	950		
B.	59	1030		

Remarks.	Left.	Station.	Right.	Remarks.
B. and Cor.	40	1080		
B.	40	1110		Cross h. into Fd. C
Leave off	45	1182		
		1312		to No. 1
		No. 2		
Cross B.	50	00		
B. and Cor.	20	58		Cross h. into Fd. A
B.	30	160		
B.	60	200		
B.	88	430		
B.	100	505		
B.	90	612		
B.	80	647		
B.	90	770		
B.	71	822		
B.	80	850		
B.	58	880		
B.	48	912		
B.	00	943		to No. 10
Cross B.	50	943		
		No 10.		
B. and L. H.	42	00		
B. and W. H. L.	135	00		
B. and L. H.	60	50		
B. and W. H. L.	140	50		
Pit	25	125		
Lane	26	155		
Cross L.	100	155		
L.	15	288		
Cross L.	70	288		
L.	00	285		to B
Cross L.	66	285		
		No. 4		
Lane	62	150		

Remarks.	Left.	Station.	Right.	Remarks.
Cross L.	130	150		
L.	73	300		
Cross L.	130	300		
L. and Cor. Fd. B	72	419		No. 11
		440		Cross h. into Fd. D
L.	90	474		
Cor. House	30	620		
W. Cor. House	115	620		
Cor. House	40	660		
W. Cor. House	110	660		
L.	70	768		
Cross L.	120	768		
L. Cor. 54	42	950		to No. 12
Cross L.	100	950		
		No. 12		
	49	00		
	22	120		
	00	220		to C
		C		
	25	90		
	34	170		to No. 6
		No. 6		
	71	00		
		180		No. 5
	40	440	70	Corner Field B
	30	525	60	
	15	710	36	
	22	834	40	
Leave off	50	900	22	
		958		to No. 13
		No. 13		
	80	00		
		50	30	

Remarks.	Left.	Station.	Right.	Remarks.
	50	73	40	
	20	110	40	
	15	120	40	Corner 60
	00	150		Cross h. into Fd. C
	10	210		No. 14
	20	340		
	20	480		
Leave off	10	586		
		630		Cross h. out of Fd C
		710		to No. 6
		No. 14		
		260	40	N. E. cor. Fd. A
		490	50	
		680	60	
		872	80	
		1090	90	
		1280	75	Leave off
		1455		to No. 2
		No. 11		
	40	125		
Leave off	30	322		
		445	Turn	left 260 to No. 5
		No. 3		
		150	36	
		224	40	
		370	30	
		550		Cross h. into Fd. A
Leave off	55	640		
		724	Turn	left 350 to No. 14
		No. 7		
Corner	80	39		Cross h. into Fd. C
	00	140		Cross h. into Fd. F
		240	50	

Remarks.	Left.	Station.	Right.	Remarks.
		420	70	
		540	72	
		670	50	
		780	40	Leave off
		870		Cross h. into Fd. C
		980	Turn	right 140 to No. 1
		No. 8		
		100		Cross h. out of Fd F
		420	50	
		580	60	Leave off
		710		to No. 3
		No. 3		
B. and Corner	40	00		
Cross B.	80	00		
		80		Cross h. into Fd. A
B.	40	150		
Cross B.	70	150		
B.	20	260		
Cross B.	59	260		
		360		to A.

EYE PLAN.



JOHN ERRINGTON, Esq.

A Plan of BANCONER 1809

CHIEF BARON ORD

JOHN ERRINGTON ESQ.R

TOTHER RIDGE

CHIEF BARON ORD

A
B
C
D
F

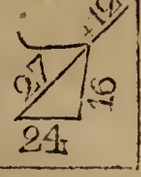
Scale of Chains 4 8

REFERENCES

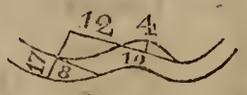
		A.	R.	P.
A	Crow Close	10	3	0.
B	Meadow	3	3	0.
C	Middle Field	14	0	18.
D	Home Close	3	0	0.
F	Brooks	15	0	22.
		46	3	0

I demand the plot and area of the following fields, from the following field book.

Remarks.	Left.	Station.	Right.	Remarks.
From	No. 1	Field A	to No 6	Mr Dunn's G.
		746		No. 2
		776		Cross h. into Lane
		820	Cross h.	out of L. into Fd. B
		832		No. 3
		1181		No. 4
		2200		No. 5
		2288		Cross h. into Fd. C
		3586		the Burn
		3593	Cross B.	into Mr D.'s ground
		3563		No. 6
From		No. 6		to No. 2 Fd. D
Burn	28	40		
B.	16	100		
B.	00	169		
		173		Cross Burn
		200		No. 7
		1018		No. 8 Field C
		1061		Cross into Fd. D
		1100	152	Burn
			159	Cross B.
		1200	137	B.
			144	Cross B.
		1220	97	B.
			104	Cross B.
		1300	65	B.
			72	Cross B.
		1400	8	B.
		1430	8	B.
		1500	20	B.
No. 2.		1511	24	Cor. 27 B
			32	Cross B.



Remarks.	Left.	Station.	Right.	Remarks.
From	No. 2	Field D		to No. 1 Fd. A
		00	8	
		100	00	
		150	00	
		200	4	
		250	6	
		300	00	
		500	3	
		740	3	
		800	00	
		850	4	
		950	8	
		1000	4	
		1037	00	Cross into Field B
		1044		No. 9
		1660		No. 1
		1738	Cross h.	into Stack Garth
		1823		Cross h. into Lane
		1880	No. 10	in the Lane
		1892	No. 12	Cross h. into Fd. A
No. 11		1900	12	
		2000	12	
		2100	8	
		2200	6	
		2400	4	
		2500	4	
		2600	00	
		2700	6	
		2712	12	Mr Silvertop's Gd.
		2725	Turn	left to No. 1 on the G. S. L. produced
Return to From	No. 6	No. 6 to 29	No. 18	Mr Dunn's gd. Field A
		40		Burn
		800		Cross B. No. 11

Remarks.	Left.	Station.	Right.	Remarks.
		820		B.
		832	Cross B.	into Mr Bonner's gd
		1700		No. 12
On the h. No. 13		1790		Cross h. into Fd. B
	00	1800		
	00	1814		Cross h. into Fd. E
		1823		No. 14 on the Burn
Cross Burn		1840	8	
		1850	12	Burn
			22	Cross cor. B.
		2600		Cross h. into Fd. F
		2650	No. 15	on top of Ridge
		3360		No. 16
		3430		Cross h. into Lane
		3487		Cross h. into Fd. A
		3500		No. 17
		3850		No. 18
From	No. 18	to 1650	No. 1	Field A No. 1
From	No. 1	Field A	to	No. 10 Fd. A
		00	7	Burn
		60	24	B.
		100	12	B.
		150	12	B.
		200	12	B.
		260	32	B.
		320	28	B.
		340	36	B.
		350	38	B.
		400	40	B.
		600	32	B.
		650	40	B.
		700	42	B.
		740	36	B.

Remarks.	Left.	Station.	Right.	Remarks.
		800	20	B.
		900	12	B.
		1000	18	B.
		1050	4	
		1100	6	
		1124		No. 10 on the hedge
From		No. 10		to No. 18
		00	00	
		15	00	
		50	10	
		150	20	
		200	30	
		300	70	
		400	78	
		500	64	
		600	45	
No. 18		648	26	
From		No. 18		to No. 20
		00	24	
		100	12	
		200	10	
No. 20		270	6	
From		No. 20		to No. 17
		00	12	Lane.
		100	12	L.
		200	22	L.
		311	14	L. No. 17
From		No. 17		to No. 2
		00	15	Lane
		100	6	L.
		200	4	L.
		300	13	L.

Remarks.	Left.	Station.	Right.	Remarks.
		400	24	L.
		500	36	L.
		600	42	L.
		700	43	L.
		800	34	L.
		900	30	L.
		1000	22	L.
		1100	10	L.
		1200	8	L.
		1300	10	L.
		1400	20	L.
		1500	34	L.
		1522	36	No. 2
From		No. 2		to No. 11
		00	36	L.
		135	60	Gate into L.
		200	50	L.
		300	16	L.
No. 11		307		Leave off
Returned to		No. 7		Field C
From No. 7		to No. 1	Field C	on the Burn
		00	73	Burn
			83	Cross B.
		100	74	B.
			81	Cross B.
		200	77	B.
			84	Cross B.
		300	92	B.
			100	Cross B.
		400	90	B.
			96	Cross B.
		500	81	B.
			87	Cross B.
		600	70	B.
			76	Cross B.

Remarks.	Left.	Station.	Right.	Remarks.
		700	66	B.
			76	Cross B.
		800	60	B.
			65	Cross B.
		850	43	B.
			50	Cross B.
No. 1		894	56	B.
		904		Cross B.
From		No. 1		to No. 8
		00	00	
		40	43	Burn
			53	Cross B.
		76	62	B.
			72	Cross B.
		100	87	Hedge on B.
			96	Cross B.
		150	66	Hedge
		200	57	Hedge leave off
		278		No. 8
From	No. 8	to	No. 5	Field B
		100	20	Hedge
		200	12	H.
		300	10	H.
		400	14	H.
		500	20	H.
		600	20	H.
		700	36	H.
		800	43	H.
		900	34	H.
Gate		937	30	Cross h. into Fd. B
		997		No. 5
From		No. 5		to No. 9
		30	50	
		100	53	

Remarks.	Left.	Station.	Right.	Remarks.
		300	56	
		450	63	Gate & tree on N.S.
		600	59	
		700	52	
		800	44	Leave off
		935		No. 9
Return to	No. 6	Mr	Dunn's	Ground
From No. 6 to	No. 3	on the	Burn	Field C
		28		Burn
		42		Cross B.
Burn	10	60		B.
Cross B.	14			
B.	20	100		
Cross B.	28			
B.	24	160		
Cross B.	30			
B.	22	200		
Cross B.	28			
B.	18	300		
Cross B.	24			
B.	14	400		
Cross B.	22			
B.	16	500		
Cross B.	24			
B.	6	600		
Cross B.	14			
	8	620		No. 3
		630	Cross B.	into Mr B.'s ground
From		No. 3		to No. 11
Burn	8	20		
Cross B.	14			
B.	4	100		
Cross B.	10			
B.	8	140		
Cross B.	14			

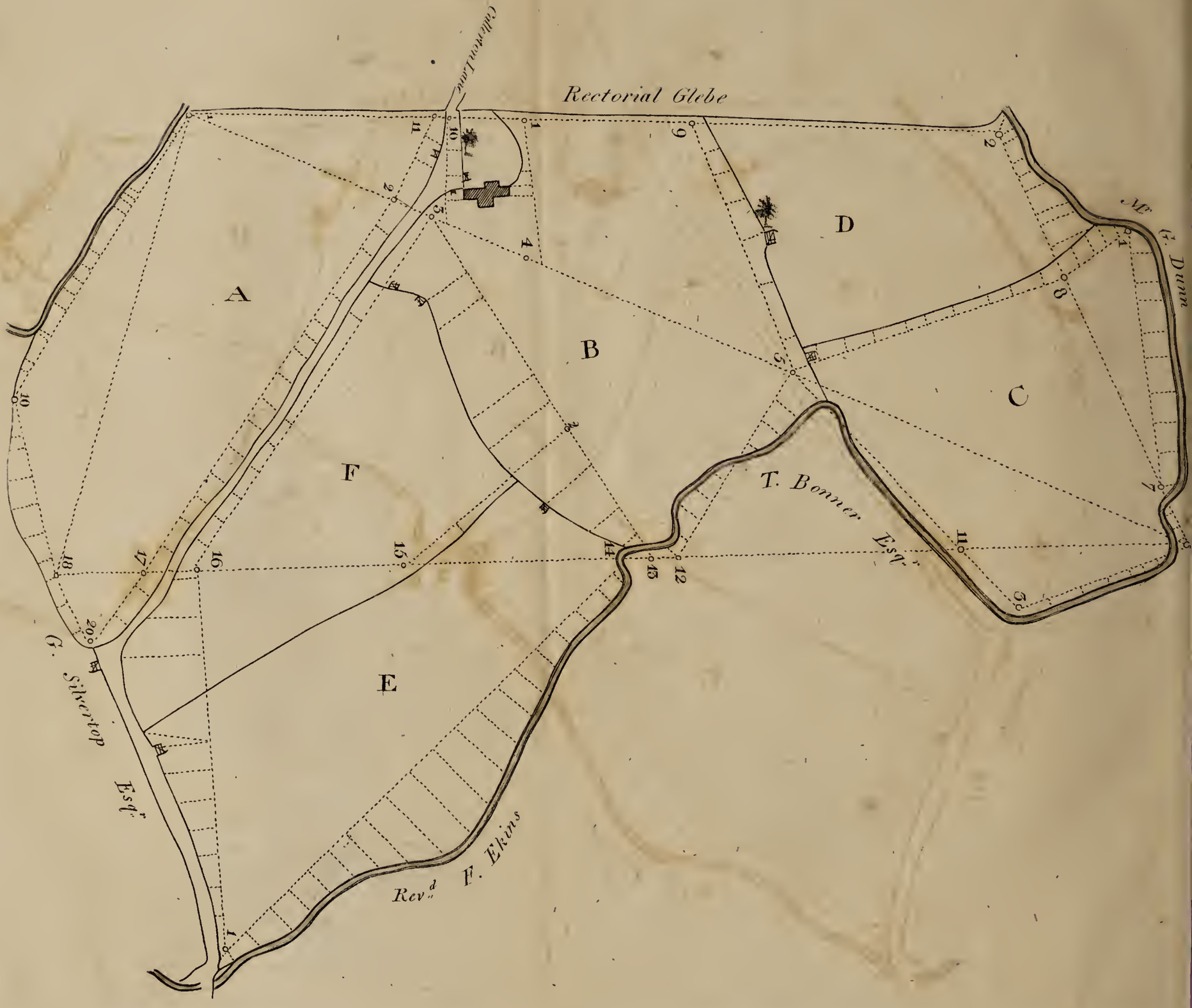
Remarks.	Left.	Station.	Right.	Remarks.
B.	20	210		
Cross B.	26			
B.	29	250		
Cross B.	35			
B.	17	300		No. 11
Cross B.	25			
From	No. 11	to	No. 5	Field B
Burn	6	100		
Cross B.	14			
B.	14	200		
Cross B.	20			
B.	21	300		
Cross B.	27			
B.	20	400		
Cross B.	26			
and leave off		530		Burn
		554		Cross B.
		582	6	B.
			13	Cross B.
		600	6	B.
			15	Cross B.
Cross into Field B		621		
		628		Burn
		636		Cross B.
		660	30	Hedge
		740	44	H leave off
		800		No. 5
From No. 5 to	No. 12	in Mr	Bon-	ner's ground
Burn	135	100		
Cross B.	144			
	104	200		
Cross B.	112			
	28	300		
Cross B.	38			

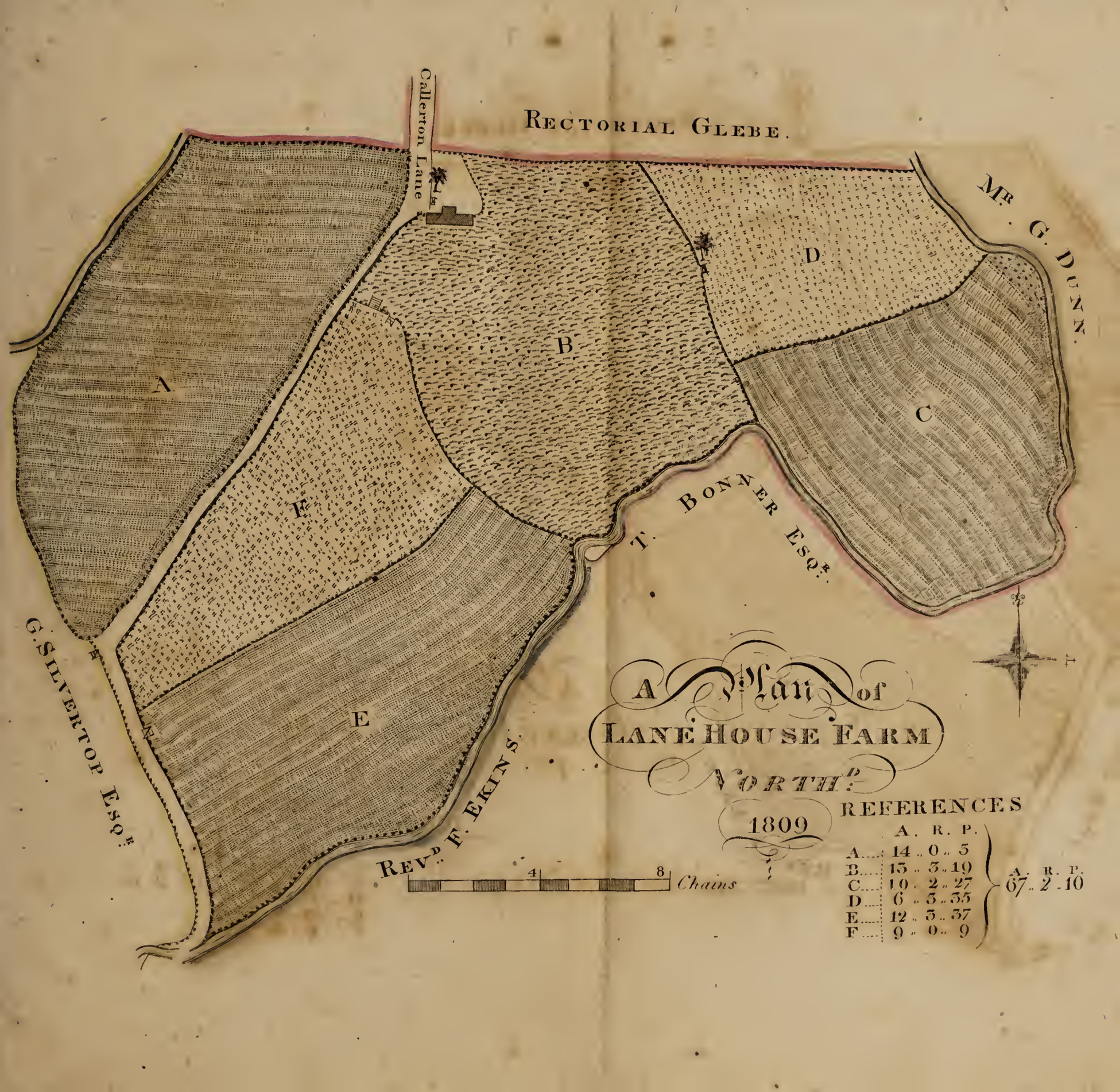
Remarks.	Left.	Station.	Right.	Remarks.
		358		B.
		337	Cross B.	into Mr B.'s ground
		400	13	B.
			19	Cross B.
		500	56	B.
			64	Cross B.
		600	90	B.
			102	Cross B.
		660	24	B.
			30	Cross B.
No. 12		740	83	B.
			90	Cross B.
Return From	to No 14	No. 14 to	No. 1	Field E Field E
Burn	50	00		
Cross B.		14		
		25		
B.	44	70		
Cross B.	52			
	72	150		
Cross B.	81			
B.	78	200		
Cross B.	85			
B.	72	300		
Cross B.	80			
B.	112	400		
Cross B.	129			
B.	132	500		
Cross B.	138			
B.	170	600		
Cross B.	180			
B.	220	700		
Cross B.	228			
B.	236	800		
Cross B.	243			

Remarks.	Left.	Station.	Right.	Remarks.
B.	283	900		
Cross B.	294			
B.	313	1000		
Cross B.	321			
B.	314	1100		
Cross B.	326			
B.	235	1200		
Cross B.	241			
B.	180	1300		
Cross B.	186			
B.	136	1400		
Cross B.	142			
B.	138	1500		
Cross B.	148			
B.	144	1600		
Cross B.	150			
B.	140	1700		
Cross B.	158			
B.	92	1800		
Cross B.	100			
Cor. B. 112	87	1900		No. 1
95 / 8 \ 112 Cross B.	93			
From	No. 1	to	No. 16	Field F
Lane	22	00		
Cross L.	75			
L.	27	100		
L.	47	200		
L.	64	300		
L.	98	400		
L.	134	500		
L.	173	600		
Gate	47 / 40 \ 240 / 50+200	700		

Remarks.	Left.	Station.	Right.	Remarks.
		868		Cross into Fd. F
Lane	277	1000		
L.	154	1100		
No. 16	64	1250		
From		No. 16		to No. 3
Lane	66	100		
L.	60	200		
	45	300		
	33	400		
	24	500		
	23	600		
	50	1000		
Leave off L.	49	1150		Cross into Fd. B
		1450		No. 3
Return to		No. 13		Field B
From	No. 13	to	No. 3	Field B
Hedge	27	27	29	Burn
			35	Cross B.
		43		B.
		55		Cross B.
H.	53	100		
H.	113	200		
Gate	208	350		
		500		No. 2
	270	600		
	272	700		
	186	1037		
Leave off G.	148	1100		
		1428		No. 3
Returned to		No. 15		Field F
From	No. 15	to	No. 2	Field B
		250	50	
		400	12	
		450		Gate into Fd. E
		465		Cross h. into Fd. B
No. 2	9 7	762		

Remarks.	Left.	Station.	Right.	Remarks.
Return to		No. 1		Field B
From	No. 1	to	No. 4	
		200	31	
		217	66	N. E. cor. Barn
		240	72	S. E. cor. Do.
		497	⌜ 80	to No. 4
Return to		No. 10	in the	Lane
From	No. 10	to	No. 3	Field B
Tree	55	130		
Gate	53	210		
N. W. cor. St.	45	244		Cross thro' W. side
S. W. cor. Do.	50	271		of the gap into Fd. B
		300	48	Lane
		342	⌜ 64	No. 3.

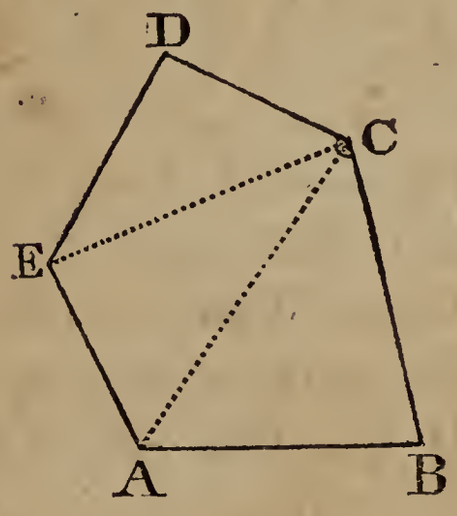

Rectorial Glebe
Calvert Lane
A
B
C
D
E
F
T. Bonner Esq.
G. Silvertop Esq.
Revd F. Ekins
Mr G. Dunn


Rectorial Glebe.
Callerton Lane
Mr. G. Dunn.
A
B
C
D
E
F
T. Bonner Esq.
G. Silvertop Esq.
Revd. F. Ekins.
A Plan of
Lane House Farm
North.
1809
References
A. R. P.
A 14 .. 0 .. 5
B 13 .. 3 .. 19
C 10 .. 2 .. 27
D 6 .. 3 .. 35
E 12 .. 3 .. 37
F 9 .. 0 .. 9
A. R. P.
67 .. 2 .. 10
4
8
Chains

SURVEYING BY THE PLAIN TABLE.

PROP. I.

To take the plan of a field from one station at one of its angles.



RULE.

Plant the table* at any angle, as C, from whence all the other angles, or marks set up,

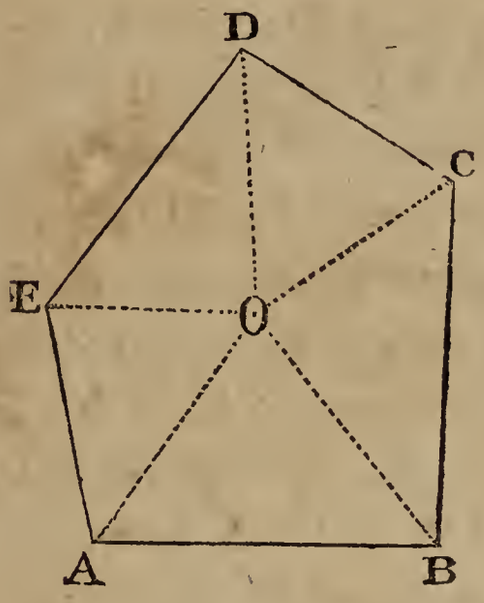
* *Plain Table*, an instrument much used in land-surveying.—This instrument consists of a plain rectangular board, of any convenient size, which is fixed by the centre, to a proper stand. It has a frame made to fit round its edges, to hold on the paper, and which is divided, on one side, into equal parts; and, on the other, from a point on the table, into degrees and minutes. A magnetic

can be seen; then turn the table about till the needle point to the flower-de-luce; and there screw it fast. Make a point for C, on the paper on the table, and lay the edge of the index to C, turning it about C till, through the sights, you see the mark D; and by the edge of the index draw a dry or obscure line: then measure the distance CD, and lay that distance down on the line CD. Then turn the index about the point C, till the mark E be seen through the sights, by which draw a line, and measure the distance to E, laying it on the line from C to E. In like manner determine the positions of CA and CB, by turning the sights successively to A and B; and lay the lengths of those lines down. Then connect the points with the boundaries of the field, by drawing the black lines CD, DE, EA, AB, BC.

needle and compass are screwed into the side of the table, to point out directions and be a check upon the sights. Besides these, it has an index with sights, and proper scales put upon it; one edge of which, being in the plain of the sights, is called the fiducial edge.

PROP. II.

To take the plan of a field from one station, at or near the middle thereof.



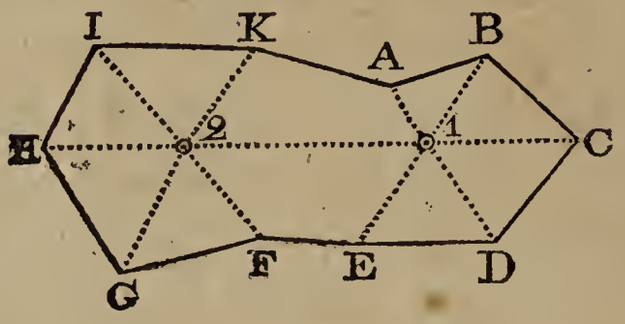
RULE.

When all the other parts cannot be seen from one angle, choose some place ⊙ within, or even without, if more convenient; from whence the other parts can be seen. Plant the table at ⊙, then fix it with the needle north, and mark the point ⊙ on it. Apply the index successively to ⊙, turning it round with the sights to each angle A, B, C, D, E, drawing dry lines to them by the edge of the index, then measuring the distances A⊙, ⊙B, &c. and laying them down upon those lines. Lastly draw the boundaries AB, BC, CD, DE, EA.

Note.—If the fences are crooked, set up marks and take the offsets as before directed.

PROP. III.

To plan a field from two or more stations taken therein.

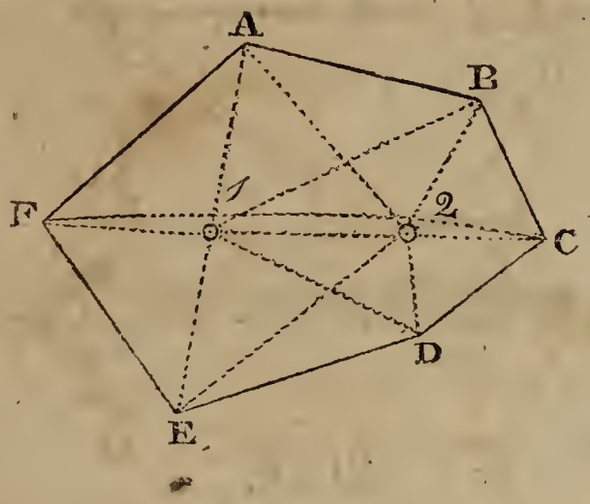


RULE.

Set up your table at ⊙1, and project such parts of the field as may be convenient—and also ⊙2. Then remove your instrument to ⊙2, lay the fiducial edge of the index along the line 1, 2, and turn the table till the sights point exactly to ⊙2. Fasten the instrument, in this position, and proceed as before.

PROP. IV.

From two stations in a field, to plan the same by measuring only from one station to the other.

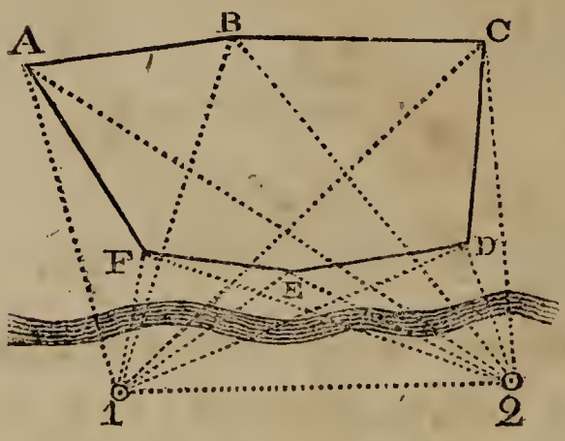


RULE.

Set up your table at ⊙1. Make a mark on your paper to represent that ⊙. Then, with your index, observe each corner of your field and ⊙2, and draw blank lines to point to each of their corners and the station. Measure to, and set off ⊙2, and there regulate your instrument as before directed. From this station, draw blank lines towards each corner of the field, which will cut the former drawn lines, where the angles of the field are to be made. Join these points, with black lines, and the work is done.

PROP. V.

To plan a field from two stations taken on the outside thereof.



RULE.

The directions given in the last proposition, will be quite sufficient for this purpose.

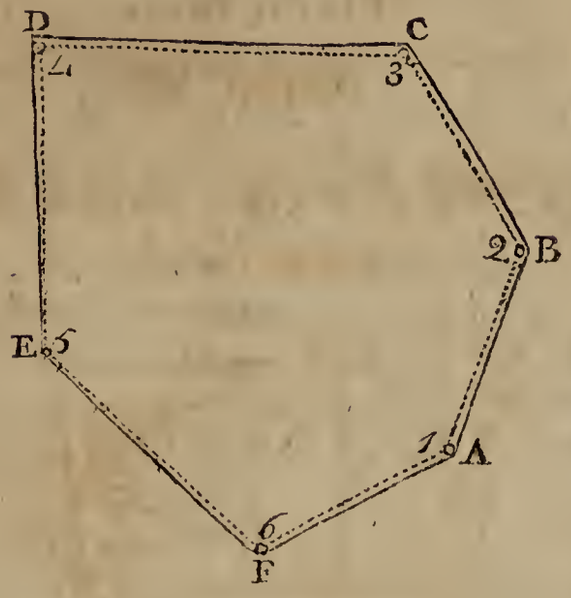
Note.—This method of operation will be found serviceable in many cases, especially in surveying any field you may not be permitted to go into.

PROP. VI.

To plan a field by going round the same.

RULE.

Set up marks near the hedges, which call stations. Then begin at ⊙1, and project the



line and off-sets to ⊙2. At ⊙2, adjust the instrument as before directed; and plan the survey to ⊙3. In this manner proceed to the end of your work.

Note.—1. In some cases a field book will be necessary, which may be made after the following form.

2. The method of working is the same, whether you go on the inside or outside of the inclosure.

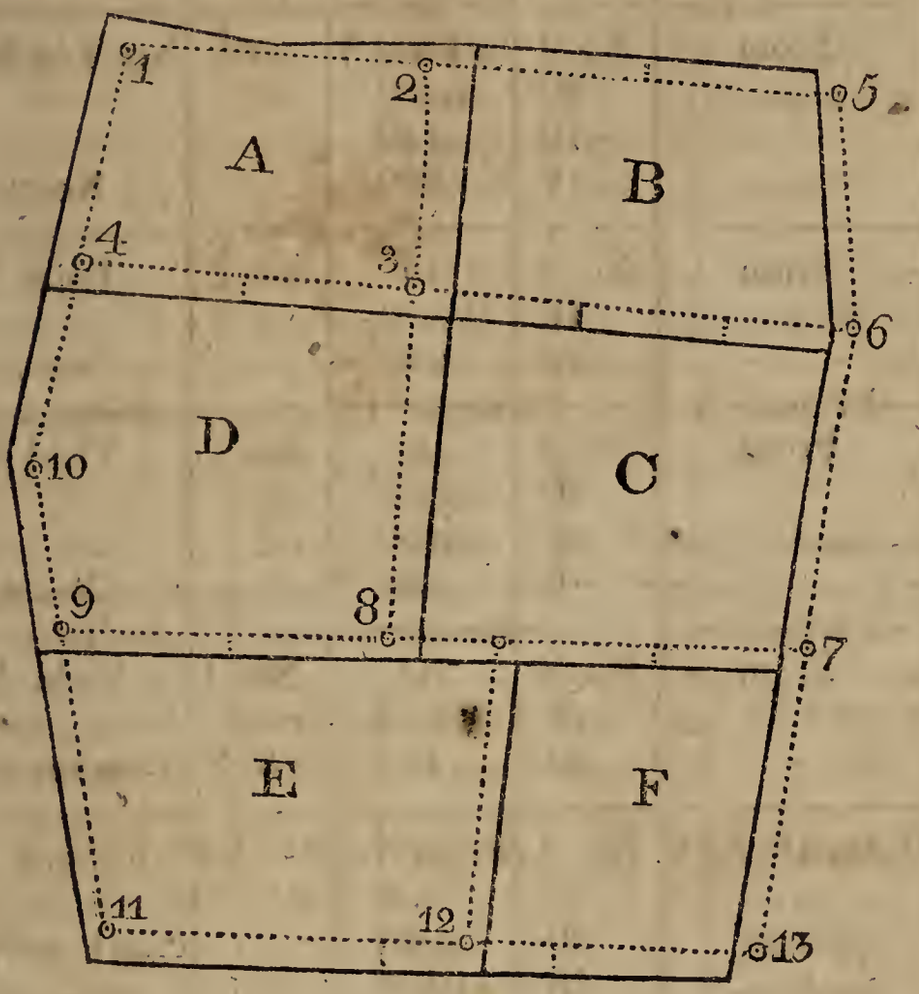
Field Book.

Remarks.	⊙	⊙ Line.	⊙	Remarks.
From		No. 1		to No. 2
		0	18	
		180	30	
No. 2		345	20	Corner
From		No. 2		to No. 3
		0		
		170	28	
No. 3		330	15	
From		No. 3		to No. 4
		0	20	
		250	10	
No. 4		520	22	
From		No. 4		to No. 5
		0	25	
		220	28	
No. 5		455	28	Corner
From		No. 5		to No. 6
		0	25	
		282	6	
No. 6		440	20	Corner
From		No. 6		to No. 1
		0	18	
No. 1		310	29	Corner. Close here.

Observe.—By this method, woodlands, marshes, bogs, pools of water, and fields of corn, may be planned.

PROP. VII.

To take the plot of several fields by circulation.



RULE.

The directions given in the last proposition, will be quite sufficient for this purpose.

Field Book.

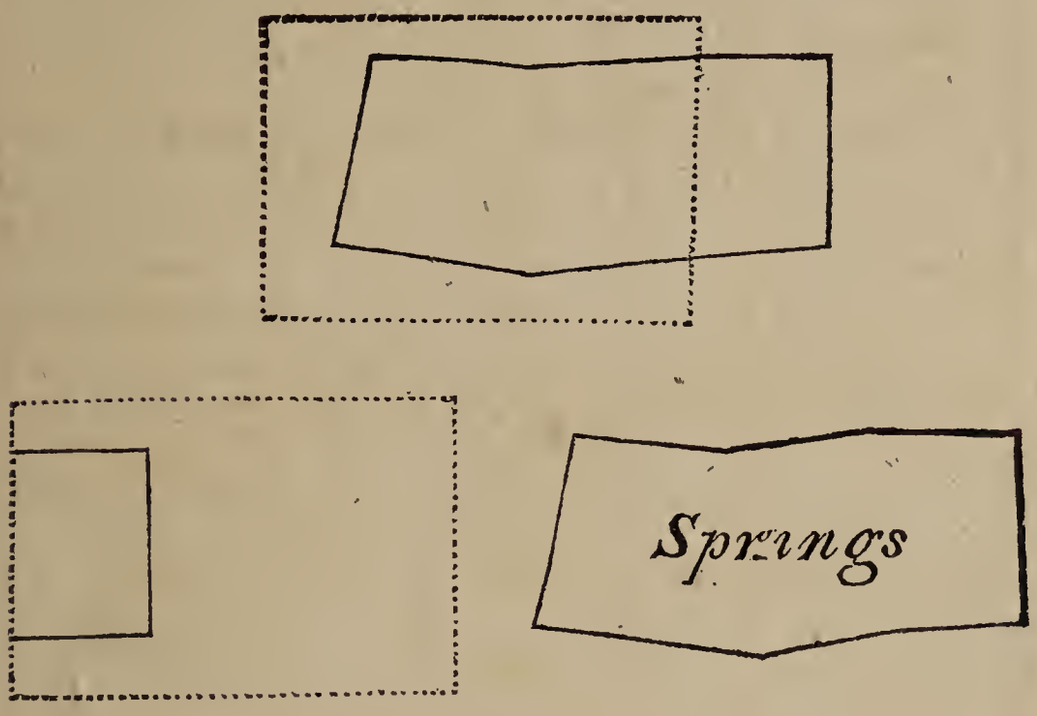
Remarks.	⊙	⊙ Line.	⊙	Remarks.
From	No. 1	in Field A	to	No. 2 in Fd. A
	20	0		
	10	140		
	18	290		No. 2
From	No. 2	to	No. 3	Field A
	18	0		
	20	220		No. 3
From	No. 3	to	No. 4	Field A
	20	0		
	25	150		
	16	330		No. 4
From	No. 4	to	No. 1	Field A
	28	0		
	24	220	No. 1	Close here Fd. A
Return to No 2	Fd. A.	From No.	2 to No	5 in open Fd.
		0		
Corner	20	20		Cross h. into Fd. B
	28	205		
Corner	16	380	Cross h.	into the open Fd.
		400		No. 5
From	No. 5	to	No. 6	in the open Fd.
		0	20	
No. 6		230	20	
From No. 6	in the	open Fd.	to	No. 3 in Fd. A
		0		
Corner	20	20		
	25	155		into Field B

Remarks.	⊙	⊙ Line.	⊙	Remarks.
	15	315		
Close here.	20	395		Cross h. into Fd. A
		414		No. 3
Return to No 6	in the	open Fd.	From	No. 6 to No. 7
		0		in the open Fd.
		20	20	
		160	20	
No. 7		320	25	
From No. 7	in the	open Fd.	to	No. 8 in Fd. D
		0		
	12	25		
	25	140		
	25	280		
		300		Bye ⊙ for closing E
Corner	25	390		Cross h. into Fd. D
		414		No. 8
From	No. 8	in Fd. D	to	No. 3 in Fd. A
		0	24	
		180	20	
		328	20	Here F closes
				into Fd. A
		345		No. 3
Return to	No. 8	in Fd. D.	From	No. 8 to No. 9
	23	0		Field D
	30	170		
	16	320		No. 9
From	No. 9	in Fd. D	to	No. 10 in Fd D
	20	0		
Corner	16	142		No. 10
From	No. 10	in Fd. D	to	No. 4 in Fd. A
		0		

Remarks.	⊙	⊙ Line.	⊙	Remarks.
Here Fd. D closes		185 200		No. 4
Return to No 9 No. 11	in Fd.	D. From 0 15 300	No. 9 20 20	to No. 11 Fd E into Field E
From No. 12	No. 11	in Fd. E 0 195 350	to 15 30 20	No. 12 in Fd E
From	No. 12	in Fd. E 0 265 285	to bye 20 16 Bye ⊙	⊙ in Field C Close here Fd. E into Fd. C at 30c in the line 7,8
Return to No. No. 13	12 in	Fd. E. 0 25 100 265 290	From 25 18 20	No. 12 to No. 13 in open Fd. Cross h. into Fd. F Corner into the open Fd.
From Close F on corner of C	No. 13 25 20	in the 0 270 290	open	Fd. to No. 7 in do. No. 7.

To shift the papers in the course of a survey.

In the practice of surveying, it frequently happens, that the whole of a survey cannot be contained within the compass of a sheet of paper. When this is the case, you must take off one sheet and put on another. This may be performed by the following rule.



RULE.

Plan as much of the survey as your paper will contain, taking care to mark where the traverse lines run off the table, and to have, at least two points of that sort. Then change your paper, and lay the marked one to the other end of the table, where make dots, from the

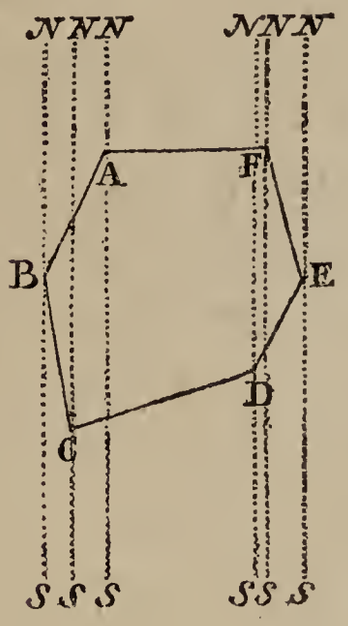
reserved points, on your new paper. Adjust your instrument, and proceed to survey from one of these dots, as if no alteration had taken place.

Observe.—If the survey be both large and hilly, it is best to divide it into several parcels by stations taken upon the hills. This method gives the true quantity of any irregular survey.

SURVEYING BY THE THEODOLITE.

PROP. I.

To take the bearings and angles of a field.



RULE.

Set up the theodolite* at A, and then adjust it, which is done by fixing the index to 360° on

* The *Theodolite* is an instrument much used in surveying, for taking angles, distances, altitudes, &c.—It usually consists of a brass circle, about a foot diameter, divided into 360 degrees, having an index with sights, or a telescope, placed upon its centre, about which the index is moveable. It has also a compass fixed

the limb, bringing the south end of the needle to the flower-de-luce in the box, and making the limb of the theodolite level and fast.—This done, move the index, till you see, through the sights, the object B, and the end next you will cut on the limb the bearing, which will also be pointed out by the south end of the needle. Then, remove the instrument to B, take a back observation of the point A, and make the limb fast; after which view the object or point C, and the end of the index which is next you will give the angle, and the south end of the needle will note the bearing. Thus proceed till you have gone round the whole field,—entering the bearings and angles in a field-book, as below.

	Bearings.		Angles.	
A	206°	00′	104°	00′
B	173	45	147	45
C	84	30	90	45
D	32	00	127	30
E	347	45	135	45
F	282	00	114	15

to the centre, which points out the bearings and checks the sights. The whole of this apparatus, which is variously made, different persons having their several ways of contriving it, is fixed upon a stand of convenient height, and may be raised, lowered, or inclined at the pleasure of the surveyor.

Note.—1. The truth of the angle and bearing, may be proved by adding the last bearing to the present angle, and substracting 180° from the sum, and the remainder will be the present bearing. Or the present bearing may be added to 180°, and the preceding bearing deducted from the sum, and the remainder will be the present angle. But when the number to be subtracted is greater, add 360° to the less number, and perform subtraction as before; and when the remainder exceeds 360° deduct 360° from it, and the remainder will be the bearing or angle.

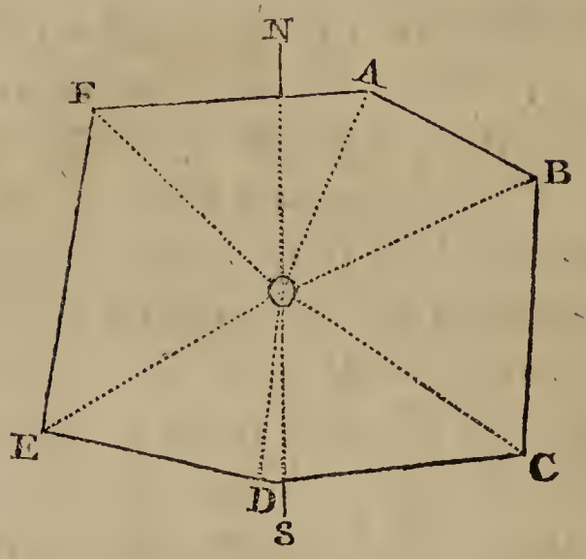
2. If 180° be multiplied by a number less by 2, than the number of the internal angles of a field, the product will be equal to the sum of all the angles in the field, when the work is right—*i. e.* when the plan will close. —If there be external angles, use their complements to 180°.—So in the above figure, the number of internal angles is 6; hence 180×4 $(=6-2) = 720° =$ sum of all the angles, which corresponds with the sum of the angles in the field-book.

PROP. II.

To survey a field A B C D E F, from one station ⊙, at or near the middle.

RULE I.

Set up the theodolite at ⊙, and adjust the instrument. Then direct the index to the corners



A, B, C, D, E, F, respectively and it will cut the limb of the instrument at the several bearings. Measure the distances (with a chain) from the station, to the said corners.

Rule II.

Adjust the theodolite at ⊙1, and direct the fixed sights to A, fasten the limb, and direct the moveable sights to the several corners B, C, D, E, F; and the index will cut on the limb the angles.—The bearings, angles, and distances are as expressed in the subjoined field book.

Field Book.

	Bearings.		Angles.		Distances.
					LINKS.
A	15°	30′	0°	00′	345
B	76	45	61	15	450
C	128	00	112	30	468
D	187	30	172	00	320
E	242	00	226	30	440
F	305	00	289	30	420

III. To draw the Plan.

Draw the meridian N. S. in which assume any point ⊙ for the station; on which lay the centre of a protractor,* (its diameter coinciding with N. S.) and prick off, close by its limb, several bearings, as they stand in the preceding field-book. From ⊙ draw the lines ⊙A, ⊙B, ⊙C, &c. upon which, lay the respective distances in the said field-book, and join the points A, B, C, &c. completing the plan.—Or, draw

* The *Protractor* is a mathematical instrument, chiefly used in surveying, for laying down angles upon paper, &c.—The simplest and most natural protractor consists of a semicircular limb, commonly of metal, divided into 180°, and subtended by a diameter; in the middle of which is a small notch, called the centre of the protractor. And for the convenience of reckoning both ways, the degrees are numbered from the left hand, towards the right, and from the right hand towards the left.

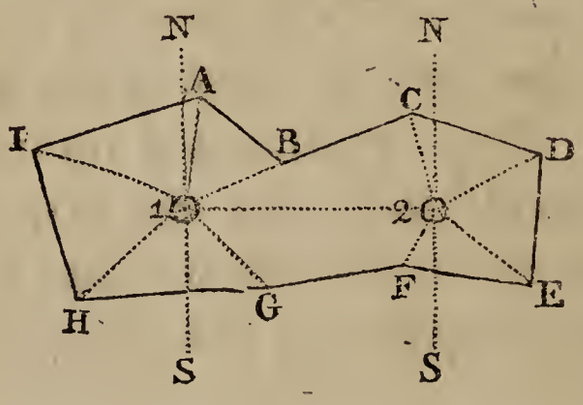
⊙A at pleasure, and lay the diameter of the protractor along the line ⊙A; then prick off, close by its limb, the several angles, and proceed as before.

Note.—1. Sometimes the surveyor only takes the angles, without noting the bearings.

2. When the fences are crooked, offsets must be taken.

PROP. III.

To survey a field A B C D E F G H I, from two or more stations taken therein.



RULE I.

Choose the stations, and adjust the theodolite at ⊙1, and take the bearings and angles of A, B, ⊙2, G, H, I; then remove the instrument to ⊙2, fix the index to the bearing thereof, and take a back observation to ⊙1, and fasten the

limb; then take the bearings and angles of C, D, E, F. Measure the distances from each station to the respective corners, as also the distance between the two stations.

Rule II.

Choose the stations, and adjust the theodolite at ⊙1. Then take all the angles of the field, and also ⊙2. Measure the distance from ⊙1 to ⊙2, and from it, take also all the angles of the field. And the intersection of the lines will determine the angular points, when the figure is drawn.

Field Book.

	Bearings.	Angles.	Distances.
	⊙ 1		LINKS.
A	8° 20′	0° 00′	280
B	76 50	68 30	275
⊙ 2	95 00	86 40	650
G	141 00	132 40	260
H	231 30	223 10	345
I	332 30	324 10	375
	⊙ 2		
C	348° 00′	339° 00′	220
D	75 30	67 10	276
E	152 15	143 55	307
F	247 15	238 55	215

III. To draw the Plan.

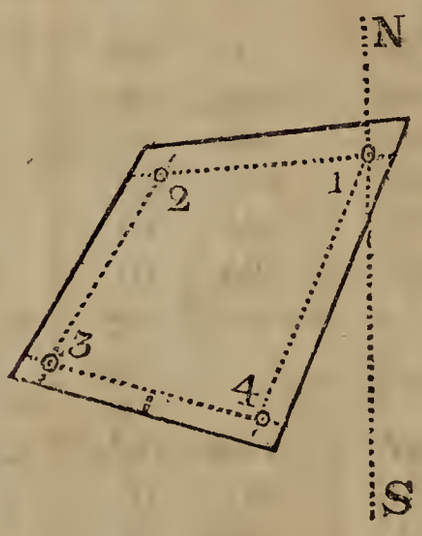
Lay down the part A B G H I, as directed in the last proposition, and make the line 1, 2, equal to the distance between the stations. Through ⊙2, draw the meridian N. S. and proceed as before for the rest of the plan C D E F.

Note.—1. In like manner, as shewn in Rule 2d, may a field be planned from two stations, taken without the field, when the corners can be seen.

2. This method will likewise be of use, in obtaining the survey of a field which is inaccessible, provided the hedges are straight, and the corners can be seen.

PROP. IV.

To survey a field by going round the same.



Rule.

Set up marks near the corners, which marks

are called stations. Then, beginning at ⊙1, take the bearing there; and measure the distance to ⊙2, and all such offsets between ⊙1, and ⊙2, as seem necessary; take a back observation to ⊙1, and the angle, or angle and bearing to ⊙3: And thus proceed till you have gone round the field.

Field Book.

Remarks.	Offsets.	⊙ Line.	Offsets.	Remarks.
		⊙ 1		
	B	264° 10′		
		0	25	J. Wilson's ground
No. 2		290	28	
< 120° 10′				
B 264 10		⊙ 2		
386 20	<	122° 10′		
180 20	B	206 20		
206 20=B		0	30	W. Graham's gd.
No. 3		298	30	
		⊙ 3		
	<	76° 45′		
	B	103 05		
		0	33	R. Jackson's gd.
		115	30	
No. 4		290	31	
		⊙ 4		
	<	98° 45′		
	B	21 50		
		0	30	C. Charleton's gd.
No. 1		390	35	Close here.

II. To draw the Plan.

Draw the meridian N. S. in which choose any point ⊙1, for the first station; to which apply the centre of a protractor, and lay down the bearing at ⊙1, in the field book, and draw the line from No. 1, to No. 2, which make equal to 290 links;—lay down the offsets and draw the hedge.—Then through the remaining stations, draw the respective meridians parallel to the former one, N. S. and proceed as before directed, till the plan is completed; always taking care to lay down the lines and angles attentively to prevent mistakes.

Note.—As the theodolite cannot be fixed exactly in the corner of a field, it will often be found necessary, on account of the fences, to take offsets though the hedges be straight.

MISCELLANEOUS EXAMPLES.

Dimensions, observations, &c. of part of an estate belonging to T——— B———, of L———, Esq. in the parish of C———; taken November 15, 1803.

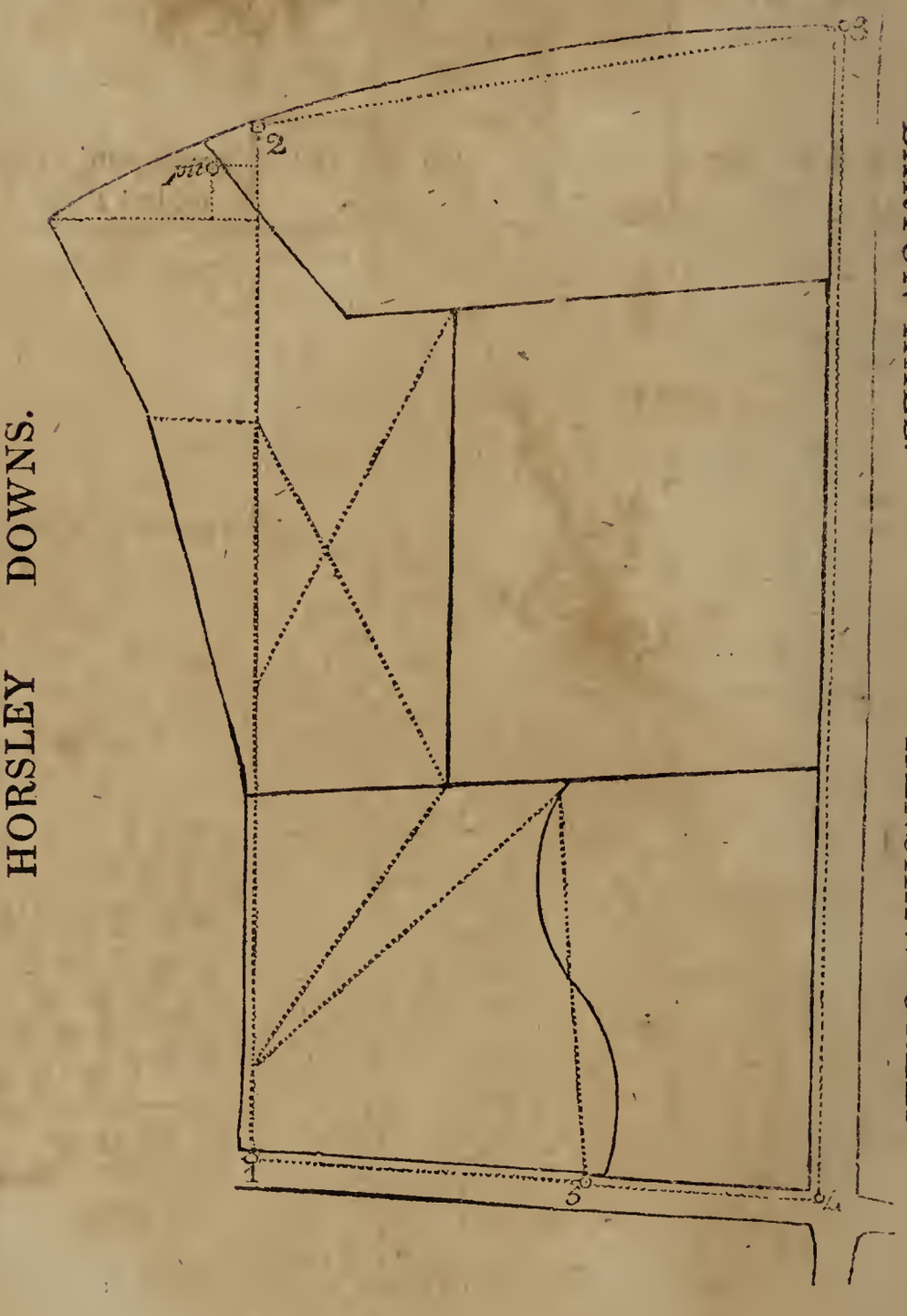
Remarks.	Left.	Station.	Right.	Remarks.
		□ 1st.		
<		103° 20′		
Corner	20	23		Through g. and h.
				45° 00′ cor. wood
		200		< to station
	40	468		Through g. and h.
to Cor.	36	720		
		720		< 92° 00′ h. to St.
	20	934		< 19° 20′ 2d. cor. wood to St.
	133	1582		< 29° 25′ b. st. to 1st. cor. wood.
1 12 p. cor a pit.		1634		in line wood hedge
4 32		1634		< 69° 00′ h. to St.
	432	1992		
Through hedge		2000		< 31° 50′ b. st. to h.
Per cor. a pit		2168		
		2230		1st. line
		□ 2d.		In 3d. piece
		110° 20′		
		0		Per. this to cor.
	40	8 03		

Remarks.	Left.	Station.	Right.	Remarks.
	27	13° 40′ 14 21		2d. Line
		□ 3d. 69° 40′		In Lane
	85	0		
		540		A gate into 3d. piece.
	22	580	14	Against 3d. cor. of wood.
		2005		A gate into wood
		2044	11	To cor. of wood
	00	2900		
To cor. Lanes.	80	2970	07	To cor. 5th. piece
		3020		3d. Line
		□ 4th. 76° 40′		In Lane
		80	10	To cor. round agst.
		400	08	St. cross hedge
⊙ 5		420		
	45	1100	20	
	45	1360		4th. Line
		□ 5th. 118° 00′		Return
		10		Cross h. into 1st. piece.
		50	30	
		200	50	
		430		Cross h. into 5th. piece.
	20	550		
		940		5th. Line

Remarks.	Left.	Station.	Right.	Remarks.
1st. ∠		103°	20′	
2d. ∠		110	20	
3d. ∠		69	40	
4th. ∠		76	40	
		360	00	
∠4 St. line		28	00	Makes with 12 o'Clock Sun.

EYE PLAN.

HOLME HILL.



A Plan of SUNNYSIDE 1809

HORSLEY DOWNS

HOLME HILL

NEWTON

FROM BRUNTON TO HEPSCOT

6 1 33.

6 0 33.

7 2 30.

11 2 25.

4 2 23.

ROAD FROM BARTON TO TOTHERTON

ROAD

HENSHAW GREEN

Scale of Chains 4 8

BARTON HALL

Observations and dimensions of land lying in the parish of W———, in the County of N———: Part of the estate of ——— ———, 19th. Nov. 1803.

Remarks.	Offsets.	Station.	Right.	Remarks.
		⊙ 1		In Charlton Fd
	B	256° 10′		
Cor. of Cow pasture		20	ag. 15	Cor. of Tur. Leases.
Hedge to pasture.	80 ag.	40		Hedge to T. Leases.
	10	280		
		300	20	
	18	563		
		⊙ 2		In the Lane
338° 00′	B	338° 00′		
180 30	>	261 50		
518 00	10	0		
256 10		20	ag. 17	H. to Home Close
261 50>		446		
		⊙ 3		In the Lane
	B	1° 30′		
	>	203 30		
	20	0	10	
1° 30′		41	ag. 10	
180 00		204	ag. 10	
		261	20	
181 30	35	290	18	
Gate into Cow pasture				
360 00				

Remarks.	Offsets.	Station.	Offsets.	Remarks.
541° 30′ Hedge to Do. 338 00	20	388	ag. 24	Clave's Crofts h.
203 30>		435		
		⊙ 4		In the Lane
	B	349° 30′		
	<	168 00		
	ag. 20	90		
	13	140		
Gate into Garrot Fd		220	0	On Stocking h.
	16	500	0	
Hedge to Fd.		626		
		⊙ 5		In the Lane
	B	13° 50′		
	>	204 20		
	10	0	20	
		64	12	
	35	152		
	30	236	10	
		⊙ 6		In the Lane
	B	93° 30′		
	>	259 40		
Cor. in Stocking	0	10		Cross h. into Stock-
	6	270		ing
	3	500		
	40	750		
		⊙ 7		In Stocking
	B	193° 30′		
	>	280 00		
Hd. to wood	23	00		
	60	335		
	45	620		

Remarks.	Offsets.	Station.	Offsets.	Remarks.
	ag. 20	668 680		
H. to Stocking	B > 10 10	⊙ 8 229° 00′ 219 20 0 268		In Stocking
Cor. h. to Stocking	B > 30	⊙ 9 268° 30′ 219 20 22 300	 20	In Stocking Close Stockg. here. Hedge to Lane in cor. next to Clave's Crofts.
Return to	B <	⊙ 9 192° 00′ 143 00 20 90 220 350 361	 20 20 20 	 Into Home Close Clave's Crofts h. Garden Pales Corner of Orchard Hedge
	B >	⊙ 10 264° 40′ 252 40 205 250 255	 0 20 	In Home Close On Orchard h. Close here Out lines of Orchd Gar. &c. close on h. next the Lane
Return to	B	⊙ 8 105° 00′		

Remarks.	Offsets.	Station.	Offsets.	Remarks.
	<	91° 30′		
	.	19		Cross the h. into Home Close
H. to wood corner	5	24		
	37	353		
	28	465		
		⊙ 11		In HomeClose
	B	193° 30′		
	>	268 30		
		130		
H. to Home Close	ag. 61	476		
Corner	18	727		
		⊙ 12		In HomeClose
	B	259° 00′		
		246 20		
	ag. 28	65		
	48	268		
		667		Close here
				Close to Home Close on the h. to lane next Turfy Leases
Return to		⊙ 12		
	B	189° 20′		
	<	176 00		
		20		Into Crabtree Close
		60	55	Cor. h. to T. Leases
		612	12	Corner
		618		Into Charlton Fd.
		642		
		⊙ 12		In CharltonFd
	B	262° 40′		
	>	253 20		
	0	10	28	
		510		

Remarks.	Offsets.	Station.	Offsets.	Remarks.
		530°		Reaches 1st Station Turfy Leases closes on the cor. of the hedge next Charlton Field
Return to		⊙ 13		
	B	103° 00′		
	<	94 00		
Touch on hedge to Crabtree Close		135		
	17	310		
		⊙ 14		In Charlton Fd
	B	69° 00′		
	<	146 00		
		320		
	3	545		
	26	618		
		⊙ 15		In Charlton Fd
	B	5° 00′		
	<	116		
	15	60		
		166		Into Charlton common
	120	337		
Hedge to Crabtree Close	16	563		
		645		
		⊙ 16		In Charlton common
	B	276° 35′		
	<	91 35		
		16		Into Crabtree Close
		22	30	Hedge to wood
		710		Close here
				Close Crabtree close to cor. next Home Close and wood
Return to		⊙ 16		
	B	10° 20′		

Remarks.	Offsets.	Station.	Offsets.	Remarks.
	>	185° 20′		
	22	222		
	60	386		
	69	434		
	50	611		
A gate into the wood	10	930		
	32	1110		
	86	1260		
	142	1353		
		1553		
		⊙ 17		In Charlton Fd
	B	264° 30′		
	<	74 10		
	128	225		
		318		Into Clemonson's land
	56	370		
	25	504		
	12	785		
		1240		Out wood closes on the cor. of Stocking next to Clemonson's land
Return to		⊙ 6		In Lane
	B	270° 50′		
	<	77 00		
		28		
		33	10	H. to W. Green
		288	40	
		560	10	
		932	98	Corner to River
		⊙ 18		In Garrot Fd.
	B	186° 00′		
		95 10		Ang. to bend in Riv.
	<	131 10		From ⊙ 18.
		26	75	

Remarks.	Offsets.	Station.	Offsets.	Remarks.
	56	175	82	
	25	248	53	
		300		
		225		⊙ Touch of the river brink
		422	145	
		536	110	
		620	106	
		⊙ 19		In Garrot Fd.
	B	96° 30′		
	∠	90 30		
		0	8	H. to Garrot Field continued to river
		180	0	
		390	34	
		558	50	Against h. to Cow Pasture
		890	76	
		1024	50	Close here Close Garrot Field on the hedge next to Lane
Return to		⊙ 19		
	B	186° 00′		
	L	180		
		8		Cross the hedge into Magg Meadow
		57	126	
		143	120	
		280	42	
		348	21	
		572	97	
		665	46	
		780	8	A Bridge
		900	0	
		1004	15	
		1045		
		⊙ 20		In Magg Meadow
	B	151° 40′		

Remarks.	Offsets.	Station.	Offsets.	Remarks.
	<	145° 40′		
		78	40	
		154	82	
		280	75	
		359	30	Corner to River
		⊙ 21		In Magg Meadow
	B	54° 30′		
	<	83 35		
		00	28	H. to Magg Meadow
		100 64		
		245 78		
		380 59		
		452	27	
		⊙ 22		In Magg Meadow
	B	358° 00′		
	<	123 20		
		00	28	
		147	53	A Gate
		378	28	
		600	6	
		790	30	
		890	60	
		1010	137	Close here
		1032		Magg Meadow closes on the cor. of the h. next Garrot Field
Return to		⊙ 21		
	B	143° 35′		
	<	172 35		
		22		Cross the hedge into Cow Pasture
		93	6	
		244	60	Corner to River
		⊙ 23		In Cow Pasture
	B	90° 50′		

Theodolite


John Clemonson's Land.
Wm Green's Land.
6
7
18
5
Garrot Field.
A. R. P.
8 0 15.
Stocking.
A. R. P.
6 0 36.
Out Wood.
19
8
9
11
4
A. R. P.
12 2 27
Land.
Magg
Home
A. R. P.
6 2 18.
Cow
10
3
16
A. R. P.
7 2 34
Close
Crabtree -
12
Henry Bramston's
A. R. P.
10 2 27
A. R. P.
6 3 28.
Meadow.
2
20
22
Turfy Leases.
A. R. P.
3 0 7
Pasture.
Close.
15
21
23
13
1
14
Charlton Field.

A Plan of YARISH NORTHUMBERLAND

John Clemonson's Land.

Wm. Green's Land.

Garrot Field
8 0 13

Stocking
6 0 36

Out Wood
12 2 27

Stone Croft to Dartford from Road

Mago Meadow
7 2 34

Cow Pasture
10 2 27

Home Close
6 2 18

Tufty Leases
3 0 7

Crabtree Close
6 3 28

Henry Branston's Land.

Charlton Common.

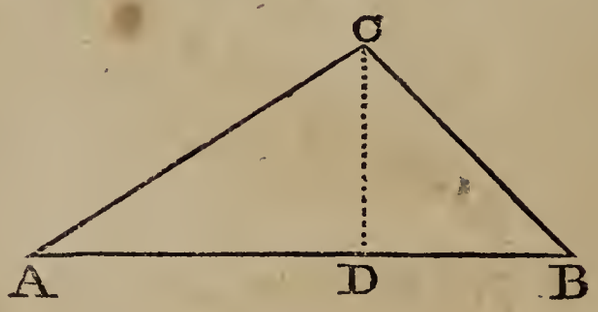
Charlton Field.

1 2 3 4 5 10 15 20 Chains

Remarks.	Offsets.	Station.	Offsets.	Remarks.
	<	129° 05′		
		205	25	H. to Cow Pasture
		245	60	
		302	62	
		428	24	
		560	20	
		680	38	
		755	58	
		842	45	Close here
		930		Cow Pasture close on the corner next Charlton Field.

SURVEYING OF HILLY GROUND.

SURVEYING of Hilly Ground is to reduce the inclined surface of a hill to a true horizontal plain, and is founded on the principles of trigonometry.*



* 1. Let A B C be a perpendicular section of a hill; and having obtained the angles of elevation A B, by a theodolite or any other instrument adapted for that purpose, measure either side A C or C B with a chain, suppose A C, then subtract the sum of the angles A and B from 180°, and there will remain the vertical angle A C B.—Whence by oblique angled plain trigonometry, as sin. ∠B : side A C :: sin. ∠A C B : base or horizontal line A B. Or suppose C B to be measured, it will be, as sin. ∠A : side C B :: sin. ∠A C B : A B.

2. Now demit the perpendicular C D, and suppose A C D, or B C D the perpendicular section, and we have by right-angled plain trig. rad. : side A C :: cos. ∠A : the length of the base A D. Or rad. : side C B :: cos. ∠B : D B.

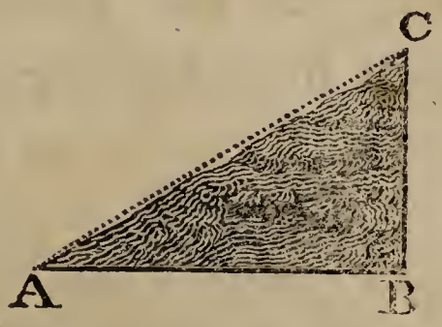
PROP. I.

To find the base or plotting line of a hill, having the hypothenuse and angle of elevation given.

EXAMPLE.

Suppose the hypothenuse or slant height of a hill A C = 800 links, and the angle of elevation A = 32° 50'; required the base or plotting line A B.

I. By Geometry.



II. By Trigonometry.

As radius	90°	- - -	10·0000000
: Hyp. AC	800	- - -	2·9030900
:: Cos. <A	32° 50'	- -	9·9244092
: Base or plot. line AB	672		2·8274992

3. If we have the angles A C D, B C D given; it will be as rad. : A C : : sin. <A C D : A D; and rad. : C B : : sin. <B CD : DB.

4. But if we wish to know the height of the hill, it will still be as rad. : A C : : sin. <A : C D; or rad. : C B : : sin. <B : C B, the height of the hill.

N. B. By an ingenious application of the above analogies, many problems relating to plain trigonometry may be solved.

PROP. II.

To find the base or plotting line of a hill, having the hypothenuse and angle of depression given.

EXAMPLE.

Admit ABC to be a perpendicular section of a hill, whose hypothenuse AC is 620 links, and angle of depression C 47° 24'; what is the length of the base or plotting line AB?

I. By Geometry.



II. By Trigonometry.

As rad. 90° - - - - - - -	10.0000000
: Hyp. AC 620 - - - - -	2·7923917
: : Sin. ∠C 47° 24' - - -	9·8669351
: The base AB 456·38 - -	2·6593268

PROP. III.

To find the base or plotting line of a hill, having the slant height of one of its sides and angles of depression given.

EXAMPLE.

Admit ABC to be a perpendicular section of a hill, the slant height of one of its sides AC, being 948 links, and the angles of elevation A and B respectively 52° and 48°; I demand the base or plotting line AB.

I. Geometrically as per Figure.



II. By Trigonometry.

180°—(52°+48°)=180°—100°=80°= ∠C.

As Sin. ∠B 48° - - - - -	9·8710735
: Side AC 948 - - - - -	2·9768083
:: Sin. ∠C 80° - - - - -	9·9933515
	12·9701598
	9·8710735
: Length of AB 1256	3·0990863

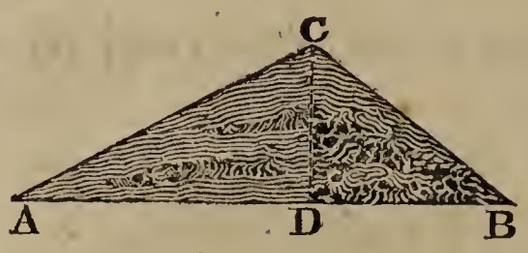
PROP. IV.

To find the height of a hill, having the hypothenuse and angle of elevation given.

EXAMPLE.

Admit ABC to be a hill, whose hypothenuse AC is 564 links, and angle of elevation A 38° 30'; what is its height CD?

I. By Geometry.



II. By Trigonometry.

As rad. 90° - - - - - - -	10·0000000
: Hyp. AC 564 links - - -	2·7512791
:: Sine ∠A 38° 30' - - -	9·7941496
: Height of the hill CD 351 links	2·5454287

A table of the links to be subtracted out of every chain in hypothenusal lines, of the several degrees of altitude or depression* subjoined, for reducing them to horizontal; and is calculated upon the principles of Trigonometry.—Vide Prop. I. Hilly Ground.

Alt. or Dep.	Allow.	Alt. or Dep.	Allow.
	LINKS.		LINKS.
4° 3′	$\frac{1}{4}$	23° 4′	8
5 4	$\frac{1}{2}$	24 30	9
7 1	$\frac{3}{4}$	24 50	10
8 7	1	27 8	11
11 29	2	28 22	12
14 4	3	29 32	13
16 6	4	30 41	14
18 12	5	31 47	15
19 57	6	32 50	16
21 34	7	33 54	17

The use of the above Table.

Suppose the hypothenusal line of a hill 600 links, and the angle of elevation 8° 7′; what is the base or plotting line?

By Inspection.

Look in the table for 8° 7′ under the column

* By the angle of depression is here meant the co-sine of the altitude.

alt. or dep. and in the opposite column, and under allow. is 1 link, which is the deduction for 1 chain; therefore 1×6=6 links is the deduction for 6 chains, consequently 600—6=594 links, the base or plotting line required.

Admit the hypothenusal line of a hill to be 800 links, and the angle of elevation 32° 50: Required the horizontal or plotting line.

By Inspection.

Look in the table for 32° 50', and right opposite is 16 links=the deduction for 1 chain; therefore 800—(16×8)=800—128=672 links, the length to be laid down, which agrees with the trigonometrical calculation, Prop. I. Ex.

Note.—In measuring up or down a declivity, it is customary to make the deduction at every chain length, by drawing the chain forward every time as much as the deduction is; *viz.* in the last intance, drawing the chain on 16 links at each chain length.

OF LAYING OUT LAND.

THE Laying out Lands is a necessary branch of Practical Surveying, which gives rules and methods to fix any quantity of ground within the limits and forms assigned it.

PROP. I.

To reduce any number of acres, roods and perches into square links.

RULE.

Reduce the given roods into perches, by multiplying by 40, to which add the perches given; this sum multiply by 615 (=square links in one square perch); then multiply the given acres by 10000 (=square links in one square acre), and the sum of these two products will be the square links required.

EXAMPLES.

Let it be required to reduce 6A. 2R. 14P. into square links.

Here $(2\times40+14)\times625=(80+14)\times625=94\times625=58750$; then $(6\times100000)+58750=600000\times58750=658750$=square links required.

Reduce 4A. 0R. 8P. into square links.

Here $8\times625=5000$; then $400000+5000=405000$=square links required.

PROP. II.

To lay out any quantity of land proposed, in a square.

RULE.

Extract the square root of the proposed area, and it will be the side of the square; then measure a right line equal to this root; raise a perpendicular on each end, equal to it; join their tops; stake all these lines, and you have done.

EXAMPLE.

Let it be required to lay out 5A. 2R. in a square, ABCD.



Here $2\times40\times625=80\times625=50000$; then $500000+50000=550000$=square links.

Whence $\sqrt{550000}=741\frac{3}{5}$ links=AB=BC=CD=DA=the side of the square, ABCD.

PROP. III.

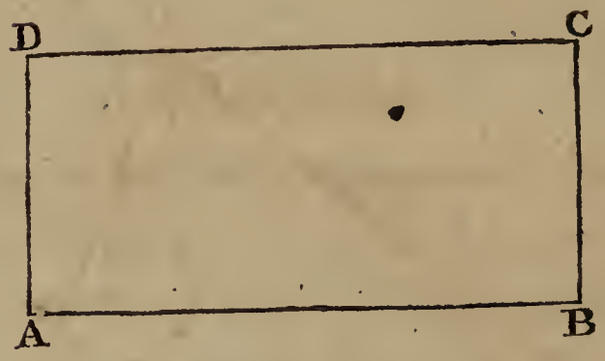
Upon a given base, to make a rectangle of a content proposed.

RULE.

Divide the content by the base; from each end raise a perpendicular equal to the quotient, and join their tops with a right line, which must be equal to the base.

EXAMPLE.

Let it be required to lay out 1A. 1R. 21P. in a parallelogram ABCD, whose length AB (=DC) is 540 links.



Here 1A. 1R. 21P. reduced to square links= 138125; and 138125÷540=256 links, nearly = AD=BC=the breadth.

PROP. IV.

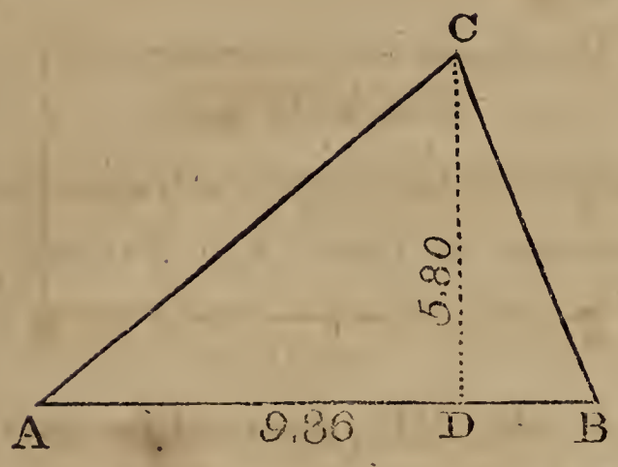
Upon a given base or perpendicular to make a triangle of a content proposed.

RULE.

Divide double the area given, by the dimension given, and the quotient will be the dimension sought.

EXAMPLE.

Lay out 2A. 2R. 34·56P. (or 27·16 square chains) in the form of a triangle ABC, whose base AB is 9·36 chains.



Here $(27{\cdot}16 \times 2) \div 9{\cdot}36 = 27{\cdot}16 \div 4{\cdot}68 = 5{\cdot}80$ chains=DC=the perpendicular.

PROP. V.

To lay out a trapezium of any proposed content having one side or base given.

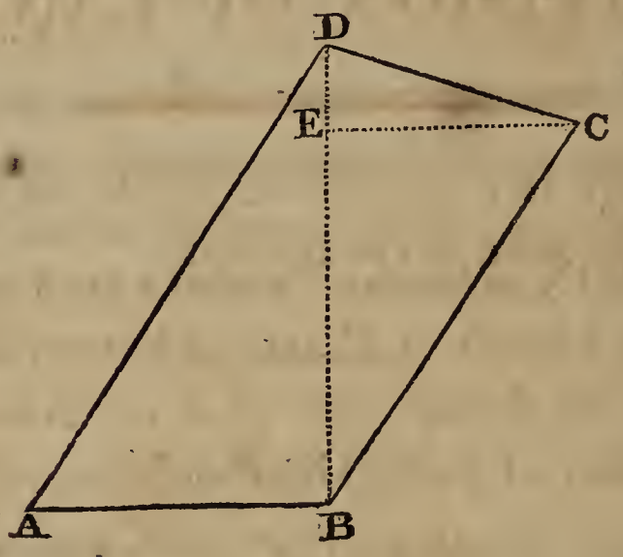
RULE.

Divide the content into two parts, either equal or unequal; then lay out one part in a triangle, by Prop. IV. Let the perpendicular of this be a base to lay out the other part in a triangle, *(Ibid.)* and this said perpendicular will be the diagonal of the trapezium.

N. B.—In the first part, the perpendicular must be erected at the end of the side; but in the second, its situation may be taken at pleasure, unless two of the sides of the trapezium have fixed boundaries.

EXAMPLE.

Let 9 acres be laid out in a trapezium ABCD, having one side or base (AB) 8 chains.



Suppose the two parts to be 5 and 4 acres. Then $50 \div 4 = 12{\cdot}5$ chains = perpendicular BD, which is also the diagonal. And $40 \div 6{\cdot}25 = 6{\cdot}40$ chains = perpendicular EC. Now join AD, DC, CB, and the trapezium is completed.

Note.—Several other figures might have been introduced here; but the foregoing seem sufficient to shew their dependance upon mensuration, in which the student should be well grounded, before he enter upon surveying.

OF THE

DIVISION OF LAND.

DIVISION of Ground is also a very useful and necessary branch of Practical Surveying, shewing how to divide any plot or draught into any number of parts, equal or unequal, according to any assigned proportion, and according to the quantity and quality of the ground about to be divided.

PROP. I.

To divide any given quantity of ground into any given number of parts, and in proportion as any given numbers.

RULE.

Divide the given piece, after the rule of fellowship, by dividing the whole content by the sum of the numbers, expressing the proportion

of the several shares, and multiplying the quotient severally by the said proportional numbers for the respective shares required.

EXAMPLE.

It is required to divide 300 acres of land among four persons, whose claims upon it are respectively in proportion as the numbers 1, 3, 6, 10, or whose estates may be supposed £100, £300, £600, £1000, per annum.

Here 1+3+6+10=20= sum of the proportional numbers; and 300÷20=15 acres.

Then 15×1=15 acres=A.'s share.
15×3=45 acres=B.'s
15×6=90 acres=C.'s
15×10=150 acres=D's

Sum=300 the proof.

N. B. This is upon supposition that the land is all of equal value.

PROP. III.

To divide any quantity of land, among any given number of persons, in proportion to their several estates, and the value of the land that falls to each person's share.

Rule.

Divide the yearly value of each person's estate, by the value per acre of the land that is allotted for his share, and take the sum of the quotients; by which divide the whole given quantity of land, and this quotient will be a common multiplier; by which multiply each particular quotient, and the product will be each particular share of the land.

Or say, as the sum of all the quotients is to the whole quantity of land, so is each particular quotient to its proportional share of the land.

EXAMPLES.

Let 300 acres of land be divided among four persons, *viz.* A, B, C, D, whose estates are £100, £300, £600, and £1000, respectively, per annum; and the value of land allotted to each is five, eight, twelve, and fifteen shillings an acre.

Then $\frac{100}{5}=20$, $\frac{300}{8}=37{\cdot}5$, $\frac{600}{12}=50$, and $\frac{1000}{15}=66{\cdot}666$; and the sum of these quotients is $174{\cdot}166 \therefore \frac{300}{174{\cdot}166}=1{\cdot}72248$ is the common multiplier.

		ACRES.	
Then	1.72248×20	= 34·45	A.'s share.
	1·72248×37·5	= 64·593	B's
	1·72248×50	= 86·124	C.'s
	1·72248×66·666	=114·832	D.'s

Sum of the shares 299·999 acres, or 300 very near, and is a proof of the whole.

Let us now change the values of the land, and see what share each will have.—Suppose A.'s 15, B.'s 12, C.'s 8, and D.'s 5 shillings an acre; then $\frac{100}{15}$=6·666, $\frac{300}{12}$=25, $\frac{600}{8}$=75, $\frac{1000}{5}$=200, and the sum of these quotients is 306·666, therefore $\frac{300}{306·666}$ =0·97826 is the common multiplier.

		ACRES.	
Then	0·97826×6·666 =	6.5217	A.'s share.
	0·97826×25	= 24·4567	B.'s
	0·97826×75	= 73·3695	C.'s
	0·97826×200	=195·6520	D.'s

The sum of the shares 299·9999 acres, which proves the whole to be right.

Let 500 acres be divided among six persons, whose estates are as follow, *viz.* A.'s £40, B.'s £20, C.'s £10, D.'s £100, E.'s 400, and F.'s £1000, per annum, and the value of the land

most convenient for each, is A.'s B.'s and C.'s each 7s.; D.'s 10s. E.'s 15s. and F.'s 12s. an acre? Now each estate divided by the value of his share of the land, will stand thus,

A.	7) 40(5·71428	Quotients.
B.	7) 20(2·85714	
C.	7) 10(1·42857	
D.	10) 100(10·00000	
E.	15) 400(26·66666	
F.	12)1000(83·33333	

Sum of the quotients = 129·99998 or 130.

Then $\frac{500}{130}$ = 3·846153 the common multiplier; by which multiply each quotient, and we shall have each person's share as follows, *viz.*

	ACRES.
A.	= 21·9778
B.	= 10·9918
C.	= 5·4941
D.	= 38·4615
E.	= 102·5641
F.	= 320·5127

Their sum is = 500·0020 which proves the whole.

N. B. If any single share should contain land of several different values, use the mean to divide his estate by.

PROP. III.

To divide any quantity of land, among any given number of persons, in proportion to their several rentals, when it consists of different parcels of different values.

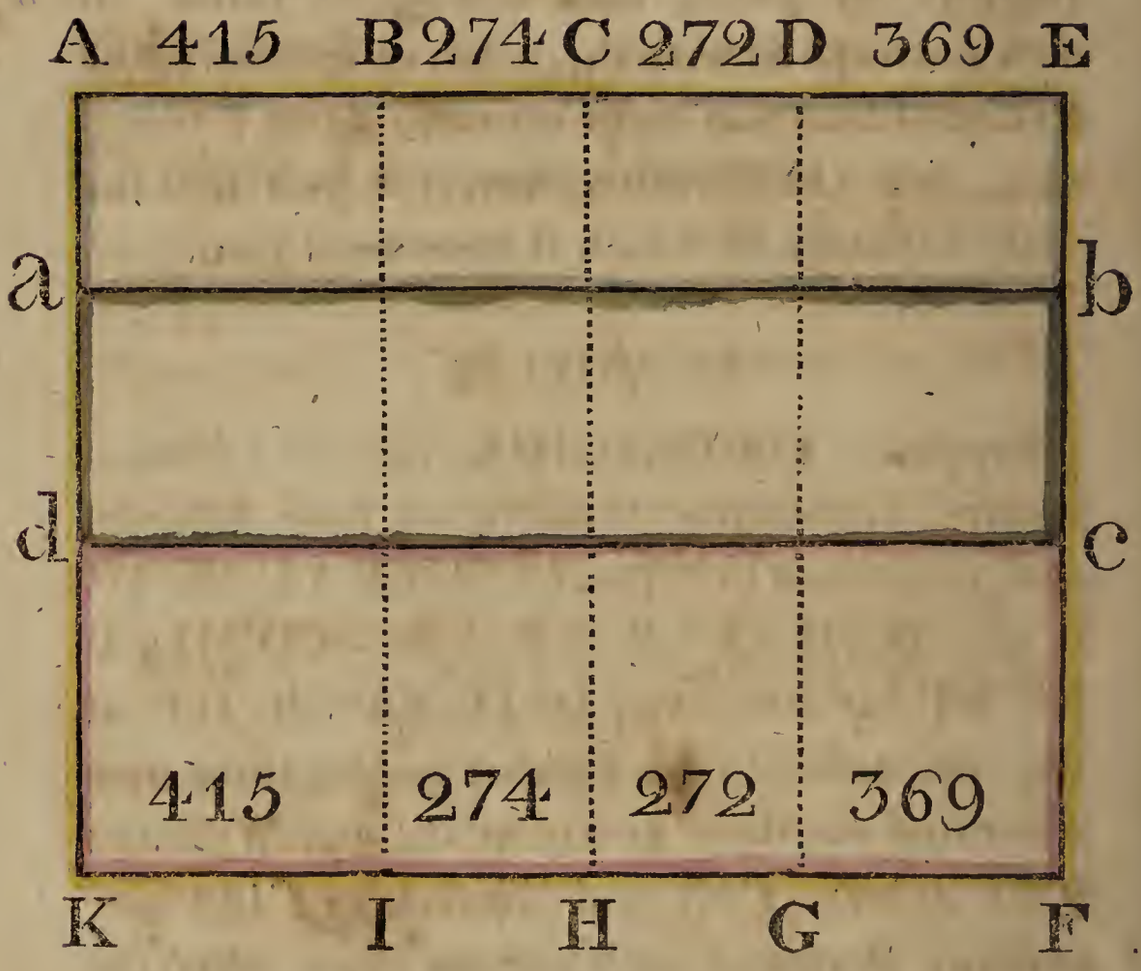
Rule.

Find what each parcel is worth at its value, and add their several sums together; then, as the sum of the several rentals, is to the whole value of the land, so is each man's rental, to his value of land: And, as the sum of the parcels, is to the sum of their values, so is one acre, to its mean price. Then, divide each man's value of land by the mean price, and the quotient will give the quantity of acres proportioned to his share; which bring into square chains by multiplying by ten; then divide the said square chains by the several distances or lengths, and the quotients will be the true lengths or breadths to be set off,—if the quantity of land be a square or parallelogram, &c. and the different parcels composing it lie parallel to one side, and the lines of division are to run parallel to the other. —But when the figure is irregular, the several quantities of land proportioned to each man's share of the whole value may be laid off by

trial; And this may be done by laying out a quantity by guess, and finding its value. If such correspond with the value of his share, the divisional line was right assumed; but if otherwise, shift the dividing line, till you find the exact situation in which it must be drawn.

EXAMPLES.

Suppose ABCDEFGHIK be a common pasture, containing 13A. 3R. of four different sorts of ground in value, *viz.* ABIK 4A. 1R. 7P. at 4s.—BCHI 2A. 3R. 13P. at 6s.—CDGH 2A. 3R. 10P. at 10s.—and DEFG 3A. 3R. 10P. at 16s. per acre, to be divided among three men according to their yearly rents, *viz.* William's £70, John's £90, and Thomas's £120, per annum: Required each persons share, when the line of division is to be parallel to AE, and the other distances are as in the subjoined figure.



Calculation.

	A.	R.	P.		s.	£.	s.	
ABIK	=4	1	7	at	4	0	17	·1750
BCHI	=2	3	13	at	6	0	16	·9875
CDGH	=2	3	10	at	10	1	8	·1250
DEFG	=3	3	10	at	16	3	1	·0000
	13	3	00			6	3	·2875=6·164375

Then 70+90+120=£280, sum of the rentals.

£.	£.	£.	£.	
As 280	: 6·164375	:: 70	: 1·5410937	W.'s value.
———	: ———	:: 90	: 1·9814062	J.'s
———	: ———	:: 120	: 2·6418750	T.'s
			6·1643749	sum of the values.

I. William's Share.

And here the ratio of the several quantities are directly as their lengths, consequently

AB	4·15× 4=16·60			
BC	2·74× 6=16·44	119·28	s.	£.
CD	2·72×10=27·20	———	=8·968	=·4484 the
EF	3·69×16=59·04	13·30		
			mean price per acre.	
13·30	119·28			

Whence $\frac{1·5410937}{·4484}$=3·435A. =34·35 Square chains: And since the area of a square is obtained by multiplying the length by the perpendicular height, we have $\frac{34·35}{13·30}$=2·58 chains =A*a*=E*b* the breadth to be set off.

So that ABCDE*ba*, is William's share of land.

For a proof of the same.

$$\left.\begin{array}{l} \frac{4\cdot15\times2\cdot58\times\ 4}{10}=\ 4\cdot28280 \\ \frac{2\cdot74\times2\cdot58\times\ 6}{10}=\ 4\cdot24152 \\ \frac{2\cdot72\times2\cdot58\times10}{10}=\ 7\cdot01760 \\ \frac{3\cdot69\times2\cdot58\times16}{10}=15\cdot23232 \end{array}\right\} \begin{array}{l} \text{£.} \\ \frac{30\cdot77424}{20}=1\cdot538712 \\ \text{W.'s proportional} \\ \text{value of the land.} \end{array}$$

II. John's Share.

Here $\frac{1\cdot9814062}{\cdot4484}=4\cdot418$ acres$=44\cdot18$ square chains; then $\frac{44\cdot18}{13\cdot30}=3\cdot32$ chains$=$ad$=$bc the breadth to be set off.

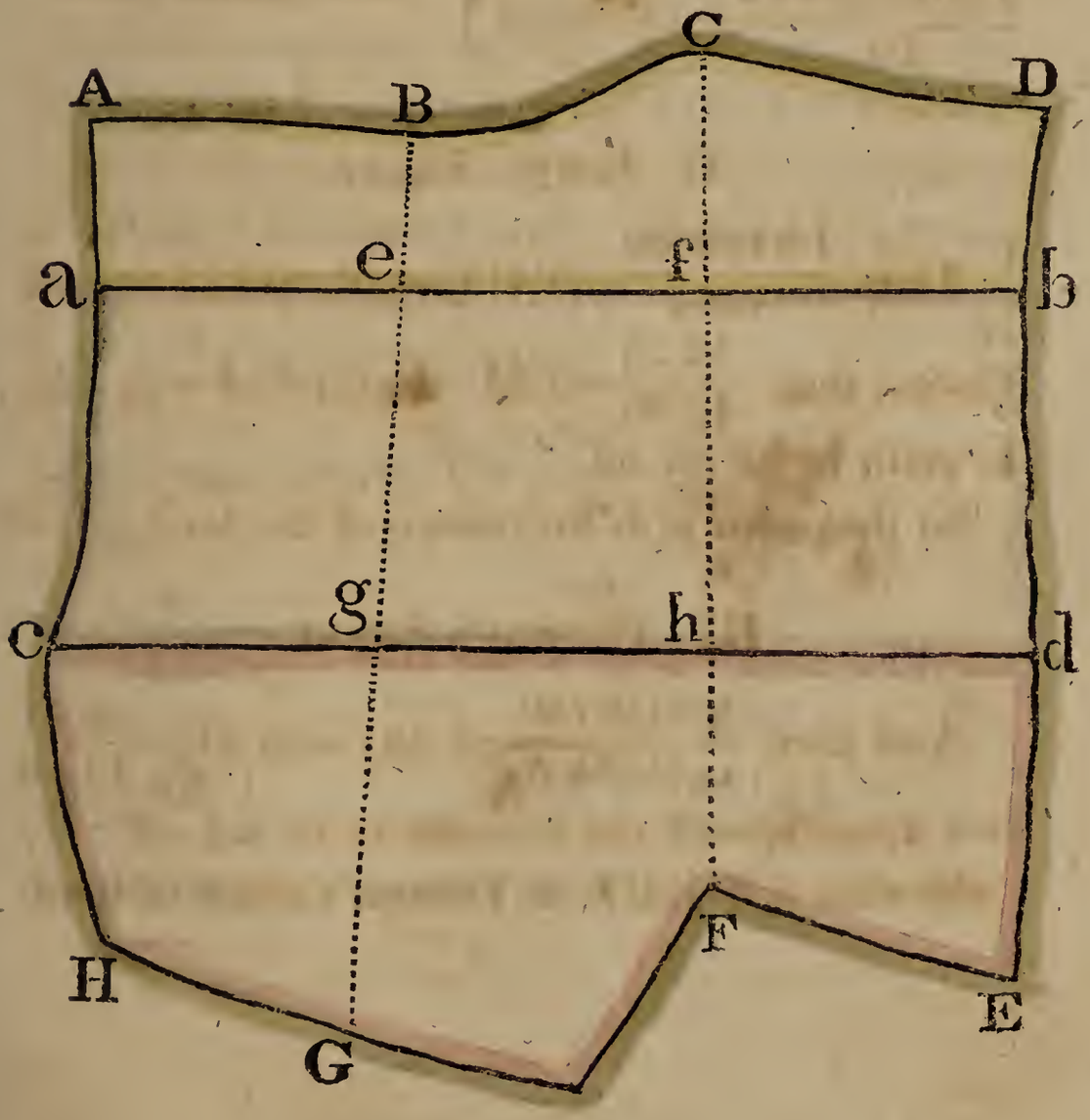
So that *abcd* is John's share of the land.

III. Thomas's Share.

And here $\frac{2\cdot6418750}{\cdot4484}=5\cdot891=58\cdot91$; $\frac{58\cdot91}{13\cdot30}$ $=4\cdot43=d$K$=c$F the breadth to be set off.

So that *dc*FGHIK is Thomas's share of land.

Suppose ABCDEFGH be a commom pasture containing 19A. 0R. 20P. of three different sorts in value, *viz.* ABGH 6A. 2R. 20P. at 8s. BCFG 6A. 0R. 35P. at 12s. CDFE 6A. 1R. 5P. at 20s. per acre, to be divided among three men according to their yearly rent, *viz.* John's £80, Peter's £100, and Edward's £130, per annum.



Calculation.

	A.	R.	P.		s.		£.	s.	d.
ABGH =	6	2	20	at	8	- -	2	14	0
BCFG =	6	0	35	at	12	- -	3	14	7½
CDEF =	6	1	05	at	20	- -	6	7	6
	19	0	20				12	16	1½

Then 80+100+130=310 sum of the rentals.

£.	£.	£.	£.	
As 310 :	12·80625 ::	80 :	3·30490	J.'s share.
——— :	——— ::	100 :	4·13104	P.'s
——— :	——— ::	130 :	5·37036	E.'s

Then by the method of trial, we gain the several proportionate shares, *viz.*

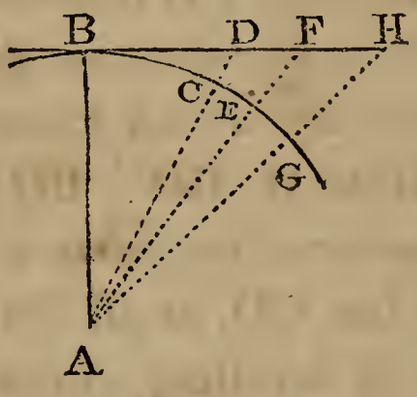
	acres.		s.		£.
AB*ea*	1·45625	at	8	per acre,	·582500
BC*fe*	1·35625	at	12		·813750
CD*bf*	1·91250	at	20		1·912500
				John's share,	3·308750

	ACRES.		s.		£
aegc	2·19375	at	8	per acre, -	·877500
efhg	2·0375	at	12		1·22250
fbdh	2·34375	at	20		2·34375
				Peter's share,	4·443750

	ACRES.		s.		£.
*cg*GH	3·0375	at	8	per acre,	1·21500
*gh*FG	2·925	at	12		1·7550
*hd*FE	2·0625	at	20		2·0625
				Edward's share,	5·03250

LEVELLING

IS the art or act of finding a line parallel to the horizon, at one or more stations, to determine the height or depth of one place, with respect to another; for laying out grounds even, regulating descents, draining morasses, and conducting water.



DEMONSTRATION.

Let BGA be a perpendicular section of the earth; through its centre A, draw BH⊥BA; and because a true or real level is every where equally distant from the earth's centre, it must therefore either be an arc BG, or some other arc parallel thereto,—the earth being considered as a perfect globe.

Draw ACD, AEF, AGH, and the line of sight BDFH, given by the operations of the levels, is a tangent, or a right line perpendicular to the semidiameter of the earth, at the point of contact B, rising always higher above the true line of level, the farther the distance is, is called the "*apparent line of level.*" Thus, CD is the height of the apparent level above the true level at the distance BC or BD; also EF is the excess of height at F; and GH at H.—The difference, it is evident, is always equal to the excess of the secant of the arc of distance above the radius of the earth.

Now the difference CD between the true and apparent level, at any distance BC or BD, may be found thus:—By a well known property of the circle $2AC+CD : BD :: BD : CD$; or because the diameter of the earth is so great, with respect to the line CD, at all distances to which an operation of levelling commonly extends, that 2AC may be safely taken for 2AC+CD in the proportion without any sensible error, it will be $2AC : BD :: BD : CD$ which therefore is $= \frac{BD^2}{2AC}$ or $\frac{BC^2}{2AC}$ nearly; that is, the difference between the true and apparent line of level, is equal to the square of the distance between the places, divided by the diameter of the earth; and consequently it is always proportional to the square of the distance.

And here the diameter of the earth being nearly 7958 miles; if we first take BC = 1 mile, then the excess $\frac{BC^2}{2AC}$ becomes $\frac{1}{7958}$ of a mile, which is 7·962 inches, or almost 8 inches, for the height of the apparent above the true level, at the distance of a mile.*—Hence, proportioning the excesses in altitude, according to the squares of the distances, the following table is obtained, shewing the height of the apparent above the true level, for every hundred yards of distance on the one hand, and for every mile on the other.

* The descent of 8 inches in a mile, is too little for the conveying of water; and therefore to give the water a proper velocity, it has been found, by experience, that 12 or 15 inches per mile, below the apparent level BH, is only sufficient.

TABLE OF CURVATURE.

Distance, or BC	Diff. of Level, or CD.	Distance, or BC.	Diff. of Level, or CD.
YARDS.	INCHES.	MILES.	FEET. INCHS.
100	0·026	$\frac{1}{4}$	0 $0\frac{1}{2}$
200	0·103	$\frac{1}{2}$	0 2
300	0·231	$\frac{3}{4}$	0 $4\frac{1}{2}$
400	0·411	1	0 8
500	0·643	2	2 8
600	0·925	3	6 0
700	1·260	4	10 7
800	1·645	5	16 7
900	2·081	6	23 11
1000	2·570	7	32 6
1100	3·110	8	42 6
1200	3·701	9	53 9
1300	4·344	10	66 4
1400	5·038	11	80 3
1500	5·784	12	95 7
1600	6·580	13	112 2
1700	7·425	14	130 1

PROP.

To find the height of the apparent above the true level, at any distance.

RULE.

Look in the table for the given distance in yards or miles, in the distance column BC, and right opposite, in the column difference of level, is the correction, or height of the apparent level

above the true.—But if the exact distance is not contained in the table,—multiply the square of the distance in yards by 2·57, and divide by 1000000, or cut off 6 places on the right hand for decimals; the rest are inches: or multiply the square of the distance in miles, by 66 feet 4 inches, and divide by 100.

EXAMPLES.

Suppose a place any where at the earth's surface, what is the difference between the true and apparent level, at 300 yards distance?

By Inspection.

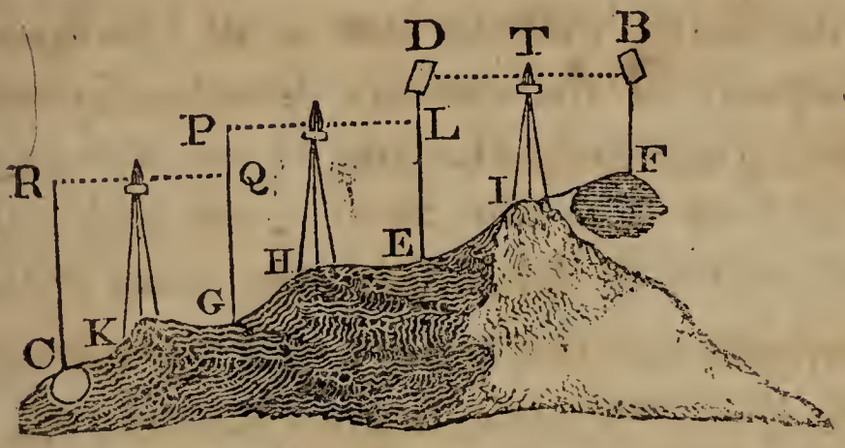
Look in the table for the distance column BC, and opposite 300 yards, in the column difference of level or CD, is found 0·231 inches, the correction or difference sought.

Admit a spring at the earth's surface,—required the difference between the true level and apparent, at 50 chains distance therefrom.

By Inspection.

Here $50 \times 22 = 1100$ yards; then look in the table for 1100 yards, and in the same line with it is 3·11 inches; answer.

Let F be a fountain, from whence water is to be conveyed to a cistern C; required the descent, or how much C is lower than F.



OPERATION.

Having chosen a proper place for the first station, as at E, fix a pole* at the point F, with a proper mark to slide up and down it, as B; and measure the distance from F to I. Then the level† being adjusted in the point I, let the mark B be lowered or raised till it is seen thro' the telescope or sight of the level, and measure

* *Levelling Poles* or *Staves*, are instruments used in Levelling, serving to carry the marks to be observed, and at the same time to measure the heights of those marks from the ground. They usually consist each of two long wooden rulers, made to slide over each other, and divided into feet and inches, &c.

† *A Level* is an instrument used to make a line parallel to the horizon, and to continue it out at pleasure.—There are several instruments of different contrivance and matter, which go under this appellation; such as the Water-Level, Air-Level, and Level with Telescopic Sights, &c.

the height BF. Then having fixed another pole at E, direct the level to it, and cause the mark D to be moved up and down till it appear through the instrument: then measure the height DE, and the distance from I to E; noting them down in the book. This done, remove the level forward to H, from whence the pole E may be viewed, as also another pole at P; then having adjusted the level in the point H, look back to the pole E, and managing the mark as before, the visual ray will give the point L; then measuring the distance EH and height EL, note them down also in the book. Then turning the level to look at the next pole P, the visual ray will give the next point P; then measure the height of P, and the distance HG, entering them in the book. Then the instrument being removed to K, find the altitudes, and measure the distance as before.—Whence, the several altitudes given by the instrument, as also the altitudes corrected by the foregoing table, with the several measured distances are as specified in the subjoined field book.

Field Book.

Back Observations.			*Fore Observations.*		
Distances.	Heights.	Cors.	Distances.	Heights.	Cors.
YARDS.	FT. IN.	IN.	YARDS.	FT. IN.	IN.
IF 1650	FB 11 3	7·0	IE 1265	ED 19 5	4·0
HE 940	EL 10 7	2·2	GH 900	GP 8 1	2·1
KG 800	GQ 7 4	1·6	KC 820	CR 8 10	1·7
3390	29 2	10·8	2985	36 4	7·8
	10·8		3390	7·8	
	28 3·2		Dist 6375	35 8·2	
				28 3·2	
			Whole diff. of level.	7 5·0	

Now having summed up all the columns, add those of the distances together, and the whole distance from F to C is 6375 yards. Then, the sums of the corrections taken from the sums of the apparent heights, leave the two corrected heights; the one of which being taken from the other, leaves 7 feet 5 inches, for the true difference of level sought between the two places F and C, which is a quantity quite sufficient to cause the water to run from the fountain F, to the cistern C.

Or, the operation may be otherwise performed, thus:—Plant the level first at the fountain F,

and from thence observe the level to the first pole; then remove it to this pole, and observe the second pole; next move it to the second pole, and observe the third pole; and so on, from one pole to another, always taking forward sights, or observations only. And then at last, add all the corrected heights together, and the sum will be the whole difference of level sought.

Remarks 1.—If the instrument be fixed exactly between the two poles, there will be no necessity for reducing the apparent level to the true one, the visual ray on both sides being raised equally above the true level.

2. The common methods of levelling are sufficient for conveying water, &c. to small distances: but in more extensive operations, the difference between the true and the apparent level must be taken into the account.

FINIS.

ERRATA.

P. 63, l. 8 from the bottom, *for* Field A, *read* Field E.
P. 71, l. 9 from the bottom, *for* Field A, *read* Field B.
P. 75, l. 4 from the bottom, in the left remark column, *insert* to No. 4.
P. 80, l. 8 from the top, *for* Nur. *read* North.
P. 89, l. 7 from the top, in the remark column, *insert* No. 5.
P. 90, l. 6 from the bottom, *for* Turn left to No. 1, *read* Turn left 40 links to No. 1.

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